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AND

OTOLOGY.

IN CONJUNCTION WITH

DR. E. GRUENING, OF NEW YORK, AND DR. CL. J. BLAKE, OF BOSTON.

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PREFACE.

THE object of these Archives, as stated in the first volume, five years ago,—viz.: to follow and further the advancement of Ophthalmology and Otology, through the medium of the two most widely spread languages of the civilized world,—remains unchanged. To attain this object, however, more certainly and more extensively, the following alterations have been made in the plan of the journal:

1. The numbers will be issued at intervals of as nearly three months as possible; four numbers, instead of two, constituting a volume. The number of pages of each issue will vary between 112 and 160.

2. About four-fifths of the space will be devoted to original papers, the remainder to reviews of the current ophthalmological and otological literature.

3. In order to secure the regular issue of the numbers, Drs. EMIL GRUENING, of New York, and CLARENCE J. BLAKE, of Boston, will assist, as associated editors, in conducting the English edition of the Archives, the former in the Ophthalmological department, the latter in the Otological.

The reviews are intended to form a report on the progress of Ophthalmology and Otology, as systematically arranged as is consistent with the rapidity of their appearance. Original papers, pamphlets or books, which their authors wish to have reviewed, may be sent to any one of the editors or associated editors. Owing to the limited space reserved for the report, it is impossible to review every new publication; the editors will,

therefore, have to select those papers which contain the most new and instructive material. As the journal serves no personal or party ends, but is devoted exclusively to scientific interests, it is self-evident that the reviews are intended to be strictly impartial, discussing the merits and demerits of the papers under consideration without regard to the rank or standing of their authors.

Original papers will be received if written in English, German, or French. The editors will, however, be doubly obliged to such contributors as may furnish papers both in English and German. Personal or unparliamentary remarks, should any such occur in a manuscript, will be expunged by the editorial pen. Every instructive contribution, relating to the anatomy, physiology, pathology, or therapeutics of the eye or ear, will be welcome provided it contain exact observations, scientifically reported. The international character of this periodical, which has been fairly maintained in the previous volumes, secures the authors an unusually large circulation of their papers. The appearance of papers in the special organ does not preclude the subsequent publication of abstracts in the journals of general medicine. Compensation will be made for important original articles, except when costly illustrations are required. A limited number of extra copies will be furnished free of charge, when requested at the time the manuscript is sent in to the editors.

Tab. A

Fig. 1.

Fig. 2 ¹/₁

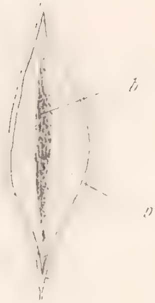

Fig. 3 ¹/₁

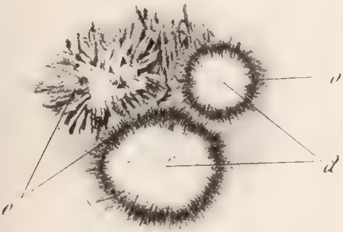

Fig. 4 ¹/₁

Fig. 5.

Fig. 7 $\frac{300}{1}$

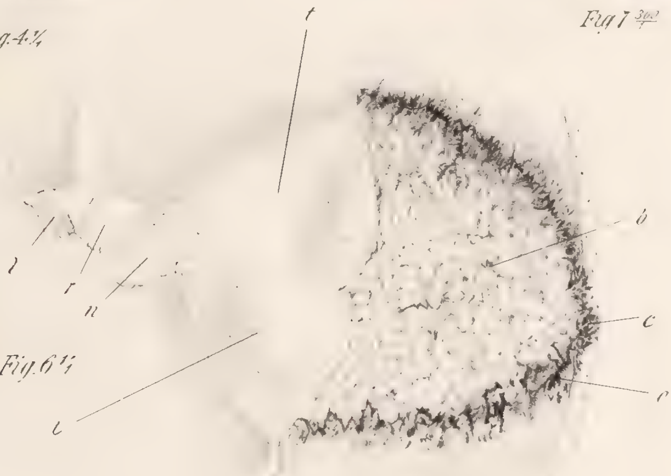

Fig. 6 ¹/₁

H. Knapp del. J. Maisonneuve lith.

A CASE OF GLIOMA OF THE RETINA WITH NUMEROUS SUBPERIOSTEAL METASTATIC TUMORS.

By Dr. H. KNAPP

AND

Dr. CHAS. S. TURNBULL.*

[With a lithographic plate, Table A.]

Helen Ulrich, æt. three years, was brought to the Clinic of the New York Ophthalmic and Aural Institute on the 9th December, 1872, for exophthalmus and total loss of sight of the right eye. Her mother stated that about seven months previously the child had been taken to a dispensary for general diseases, and there treated for an attack of "summer diarrhœa." At that time there was in the right eye some redness and pain, which increased gradually until the early part of November, when the mother noticed that the right eye protruded more than its fellow, and had a brownish yellow pupil. The color of the pupil remained the same, but the exophthalmus increased up to the time of her admission to the Hospital in December, 1872, when the following conditions were noticed:

Exophthalmus of about 2‴, sclerotic covered with enlarged and tortuous blood-vessels, marked circumcorneal injection, $+T_2$; vitreous chamber completely filled with a yellowish lustrous mass; iris of a dull-brown color, and bulging; anterior chamber shallow, pupil slightly dilated and rigid. The movements of the eyeball were diminished; a subcutaneous hard oval tumor, the size of a cherry stone, occupied the right temporal fossa. The diagnosis of "Glioma Retinæ," with extension into the orbit, was at once made, extirpation was advised, agreed to by the mother, and performed by Dr. H. Knapp.

The orbital portion of the growth was nearly as large as the globe itself. The operation, performed under anæsthesia by chloroform, was accompanied with no unusual difficulties, but attended by copious hemorrhage, which was arrested by cold sponging.

The child rallied well, but during the night had secondary hemorrhage, which was stopped by plugging the orbit with sponges. The lids and

* The clinical history of this case is by Ch. S. T., the anatomical description by H. K.

surrounding tissues were swollen and ecchymotic for the next three days, and no general or cerebral troubles followed. The wound healed without suppuration, and the child was dismissed the fifth day after the operation.

On the 8th of January the child was again brought to the Clinic. Both lids of the enucleated eye intensely ecchymotic, tumor on right temple now the size of a pigeon's egg and slightly pulsating, while a smaller one, the size of a fox-grape, occupied a similar position upon the left temple; two more had developed near the junction of the interparietal and occipito-parietal sutures, and three still smaller ones over the fronto-parietal suture. Other smaller tumors, constantly increasing in size, then formed in different places upon the cranium directly over the sutures. A local recurrence of the pseudoplasm in the eye soon filled the orbit, distended the lids, and occasioned a hemorrhage, January 13th, which was soon checked by cold application. Three new tumors as large as pigeon eggs then appeared, one behind the left ear, another on the right half of the inferior maxilla, and a third on the right side of the neck; all of which rapidly increased, especially the one upon the inferior maxilla, by which the mouth was drawn to one side.

On January 17th, the photograph, of which Fig. 1, Tab. A, is a copy, was taken with the following *status præsens:*

Out of the right orbital cavity springs a mushroom-shaped, reddish-brown tumor with an irregular, nodulated surface, pervaded by numerous blood-vessels. It pushed the nose to one side, and projected about a quarter of an inch beyond the distended lids. From this excrescence exudes an abundant viscous juice, and at various points its surface is covered with grayish-black crusts, which, when removed, leave a raw, bleeding surface. Six subcutaneous, immovable, and sharply circumscribed intumescences are felt upon the cranium, while five larger ones are situated respectively upon each temple, behind the left ear, on the right side of the inferior maxilla, and on the neck near the centre of the sternomastoid muscle. The face is distorted, the integument covering the tumors is tense, shining white, and traversed by many thick, tortuous, bluish-red vessels.

About the middle of January (a few days after the above examination) the lids of the left eye became swollen and ecchymotic, and there was marked exophthalmus, whilst the sight remained good. Ophthalmoscopic examination showed nothing more than hyperæmia of the retina, and slight swelling of the disk. The child emaciated, became very anæmic, and the tumors grew with remarkable rapidity, whilst the exophthalmus increased, without any symptom indicating a participation of the brain in the morbid process, until the end of January, when there occurred a suc-

cession of tetanic convulsions, each of which lasted about ten minutes, leaving the child in a semi-comatose condition for nearly an hour.

The curious fact was noticed, that after the child had six convulsions in twenty-four hours, the tumors, excepting that in the orbit, shrank, and the smaller cranial ones disappeared, leaving only slight depression; and for several days the child appeared to improve, its vivacity and appetite having returned. It soon sank again, constantly ground its teeth during sleep, and a new growth caused a swelling on the left and posterior portion of the hard palate. The left eye looked dull, and shreds of mucus were constantly upon the cornea. The pupil was sluggish, but free and round. The fundus oculi was congested, the optic disk white, the veins were large and full, but the arteries very small. A few days later the child refused food and sank rapidly, seeming to suffer no pain, and died of exhaustion, with no cerebral or other symptoms.

An examination of the body of the child was made by Dr. Charles S. Turnbull, and the head, which was removed entire, was placed in "Müller's Fluid."

The corpse was greatly emaciated, but beyond the atrophy of the subcutaneous adipose tissue, nothing unusual was found anywhere. The cranial portion of the head was irregularly enlarged, and the integument was very much thickened.

Anatomical Examination.

A meridional section was made through the extirpated eyeball, and continued to the episcleral tumor (Fig. 2, Tab. A). Nearly the whole globe was filled with a soft, granular substance. Only between the posterior surface of the lens and the anterior surface of the pseudoplasm was some soft fibrous tissue. The sclerotic, which separated the intra-ocular and episcleral tumors, was attenuated in different places and (under the microscope) showed the communication of the two tumors to be continuous through crooked rows of small, round cells.

A tumor nearly the size of a hen's egg was projecting from the right orbit. It not only filled the orbit completely, but penetrated through the superior orbital fissure into the cranium. The left eye showed nothing abnormal in its interior.

After removal of the scalp the sutures of the skull presented themselves as raised and markedly red lines, which, after incision of the pericranium, proved to be areolar tissue saturated with

blood. In various places on the outer surface of the skull flat, round tumors were observed, varying in size from a few lines to an inch in diameter. Sections through them showed (Fig. 3, Tab. A) that they were in connection both with the pericranium (*p*, Fig. 3) and the bone (*b*, Fig. 3), the surface of the latter being rough and corroded (*b*, Fig. 3). The substance of these tumors was finely granular, with some very red and soft fibrous stripes (Fig. 5). In the right temple one tumor was distinguished for its extraordinary size, being more than two inches in diameter. A transverse section through it showed the same conditions as in the just described smaller tumors. The bone was, however, so corroded, that in its centre it was defective. The portion of the lower jaw reaching from the symphysis to 1½″ toward the right side was the seat of a tumor, having the size and shape of a large walnut. Its base was depressed and rough in the centre, but elevated, in the shape of an osteophytic wall, at the periphery, whilst its tissue was very soft and vascular. Opposite this tumor, at the inner side of the lower jaw, was a smaller tumor of soft consistence, but yielding a grating sound when incised. Another similar tumor was found on the left half of the lower surface of the hard palate. The skull was of ordinary thickness, its inner surface showing numerous small depressions (*d*, Fig. 4), surrounded by a wall of very vascular osteophytic excrescences (*o*, Fig. 4). Corresponding to these depressions were soft, red tumors, situated on the outer surface of the *dura mater*.

The right middle cranial fossa was occupied by a tumor (*t*, Fig. 6), which was exactly opposite that situated in the right temporal fossa, and had the same appearance, structure, and nearly its size. A transverse section through it showed that it had the same relations to the *dura mater* and to the bone, as the epicranial tumors had to the periosteum and the bone.

The whole surface of the bone (*b*, Fig. 6), upon which the tumor was situated, was very uneven, soft, being slightly elevated at its periphery (*o*, Fig. 6). A section through the bone showed the defective condition (*c*, Fig. 6) which is mentioned above in the description of the tumor occupying the right temporal fossa. A similar, though smaller, tumor was situated in the left middle cranial fossa, opposite the one found in the left temporal fossa. The right optic nerve (*r*, Fig. 6), from the optic foramen to the

chiasma, was about double the size of the left (*l*, Fig. 6). Between it and the tumor in the middle cerebral fossa was situated another tumor (*n*, Fig. 6), about the size of a filbert, apparently an extension of the orbital pseudoplasm. The chiasma itself and the optic trunks, especially the right, were very soft. The inner surface of the *dura mater* was normal, the sinuses mostly filled with dark, coagulated blood; their walls being normal. The veins of the posterior lobes were greatly enlarged and filled with coagula. In the pia mater and the peripheral portion of the brain substance of the posterior lobes were numerous capillary hemorrhages. The remainder of the brain showed nothing abnormal.

The *microscopic examination* disclosed in all the tumors the same well-known structure of glioma or encephaloid cancer. The tumors were exceedingly vascular, and showed numerous hemorrhages. The subperiosteal tumors, however, contained at their base, especially toward the periphery, osteophytic formations which grated under the knife, and manifested themselves under the microscope as spiculæ of cancellous osteoid and osseous tissue. The formation of bone-substance took place, as in other parts of the body, with a pronounced line of demarcation which advanced into the gliomatous tissue (Fig. 7).

The newly-formed bone-substance was mostly cancellous, and a conversion of the original cranial substance into the same structure explains the corrosion and defectiveness of the skull at the base of the tumors. The whole formation closely resembled those tumors which have been described under the name of "sarcomata with osseous spiculæ," and of which, for instance, Professor Julius Arnold, in "*Virchow's Archiv*," has of late given an excellent description. As the tumors in the specimen under consideration were in no connection with each other, nor with the original tumor, we may fairly pronounce them metastatic. They differ, however, from the few cases of glioma metastases which are on record by the peculiar and novel feature that the metastatic tumors do not originate in the diploë, but between the periosteum and the surface of the bone. A remarkable observation furnished by this case is that in some places intra-cranial tumors corresponded to extra-cranial ones, *e.g.*, in the two temporal fossæ, which, at first sight, gave the idea of their originating from the

diploë. This idea we were compelled to discard, as not only the diploë, but even both tables of the cranium which separated two smaller tumors were found to be but little changed.

An analogous case was reported by Dr. William F. Norris, at the Pathological Society, in Philadelphia, on January 9, 1873, a short account of which may be found in the *Philadelphia Medical Times*, February 8, 1873.

A CASE OF RETINAL GLIOMA

DISTINGUISHED, CLINICALLY, BY A FAMILY PREDISPOSITION TO GLIOMA, AND ANATOMICALLY, BY THE OBVIOUS ORIGIN OF THE DISEASE IN THE INNER GRANULAR LAYER.

By Dr. J. THOMPSON, of Indianapolis,

and

Dr. H. KNAPP, of New York.*

(With two wood engravings.)

Effie Ferrin, aged twelve months, was brought to me August 29, 1873. She has always enjoyed good health. About three months previously the parents noticed a peculiar metallic lustre from the bottom of the right eye.

Status præsens.—The patient is a beautiful blue-eyed babe, with light hair, and fair complexion. The eyes both moved perfectly in all directions. The right pupil is a trifle larger than the left, and on exposing it to a bright light, while the left eye is covered, it does not contract; but no sooner is the left uncovered than the right contracts consensually. With the ophthalmoscope I find the fundus partially filled with a soft-looking substance, in the sulci of which are blood-vessels.

I immediately pronounced it a case of glioma of the retina, and urged the immediate removal of the eye. On making inquiry concerning the family history, I learned that a brother of the babe had been similarly diseased. The parents tell me that the same shining appearance of the bottom of his eye was noticed when he was two years of age; perforation took place six months later, and in five months from that date the child died. They also informed me that for some time, if even a fly touched it, the blood would run therefrom. A cousin of the patient, on the father's side, was also attacked in the left eye, in his second year, and he died in a few months after it was first noticed. The father's aunt also lost two children, between the second and fourth years of their ages, whose eyes were said to be diseased in exactly the same manner. In no case has any relative had any cancerous disease in any other organ or tissue, to their knowledge.

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* The clinical history of this case is by J. Th., the anatomical description of the specimen by H. K., to whom the eyeball was kindly sent by Dr. J. Th.—Ed.

Not quite one teaspoonful of blood was lost during the operation, and we found no enlargement of the stump of the optic nerve, or of any other tissue.

The points of interest which attach to this case, are, I think:

First. The large number of relatives who have died from exactly similar tumors, which, in every instance, first attacked the eye, and subsequently surrounding tissues.

Secondly. The early enucleation, before any other tissue appeared to be involved.

When the patient was seen for the last time (middle of January, 1874), she was in perfect health, and no symptoms of a relapse could be detected.

Anatomical Description.

The globe had the usual dimensions of an infantile eye; no abnormity was visible on its surface. The optic nerve was cut closely to the sclerotic. It was a little retracted, but exhibited no signs of disease.

When the globe was hardened in Müller's fluid, it was opened by a meridional section passing through the centres of the optic nerve and the cornea (see Fig. 1). The retina (r) was totally detached, crowded to the centre, with some folds (r_1) between the centre and the periphery of the vitreous space. On its outer surface was situated a yellowish-white, finely-granulated, soft tumor, which surrounded the retina at its emergence from the optic disc (t), and extended forward into the vitreous space in one half of the eye only. Some smaller flat (t_1) and round (t_2) tumors were seen in other places on the outer surface of the retina. The other half of the retina showed only a few small tumors, having the same appearance as those represented in Figure 1. The other parts of the specimen exhibited nothing unusual to the naked eye. Under the microscope all the tumors were composed of small, round cells, embedded in a scanty matrix, and supplied with many thin-walled blood-vessels—the ordinary structure

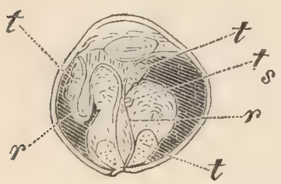

Fig. 1.

of retinal glioma. Transverse sections through the smallest tumors showed, with greatest distinctness, that the pseudoplasm originated in the inner granular layer. Figure 2 illustrates this condition.

The inner granular layer (*i*) swells by accumulation of elementary parts which cannot be distinguished from its own. The outer granular layer (*o*) is raised. At the crest of the intumescence the intergranular layer (*n*) disappears, and the tumor blends with the outer granular layer. The molecular layer (*m*) is barely indicated, and the ganglionic layer is absent. The fibrous layer (*f*) exhibits marked alterations. The radiating pillars of connective tissue are well preserved, and are attached to the

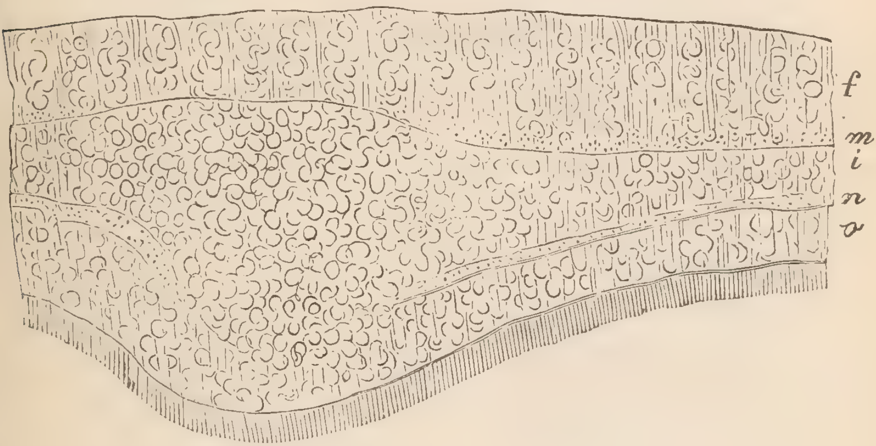

Fig. 2.

inner limiting membrane as usual. The nervous fibres, however, are replaced by small, round cells, like those of the pseudoplasm, and appear like ears of Indian corn, sheathed by the pillars of the radiating fibres. All these changes disappear gradually at some distance from the tumor, and the retinal tissue shows no abnormity, except in the vicinity of the pseudoplasms. The larger tumors pierce the outer granular layer, the outer limiting membrane, and the bacillar layer, and expand in the vitreous space between the detached retina and the choroid.

At the periphery of some of the tumors the elementary parts of the inner and outer granular layers are so blended that it could not be determined in which layer the new growth originated. Since, however, other places show the above described condition with the greatest distinctness, we have to classify this specimen among those in which the disease began in the inner granular layer. It subsequently invaded the fibrous layer without perforating the inner limiting membrane, but extended to the outer retinal layers, perforated them, and expanded freely in the space between the detached retina and the choroid. The optic nerve, the choroid, and the other parts of the eye were unaffected.

This specimen ranks with the first cases of retinal glioma, described by ROBIN and SCHWEIGGER, who, on account of the similarity of the elementary parts of the pseudoplasm to the retinal granules, considered the nature of the morbid growth to be a hyperlasia of the granular layers, in particular the inner.

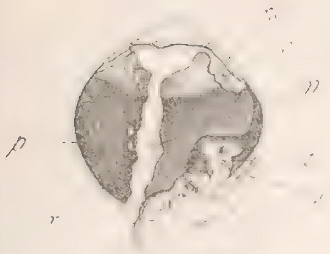

Fig. 1.

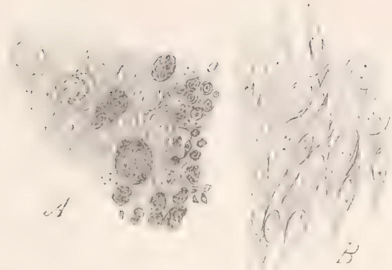

Fig. 2.

Fig. 3. $\frac{500}{1}$

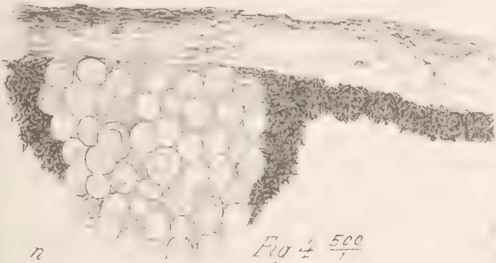

Fig. 4. $\frac{500}{1}$

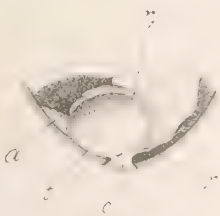

Fig. 5.

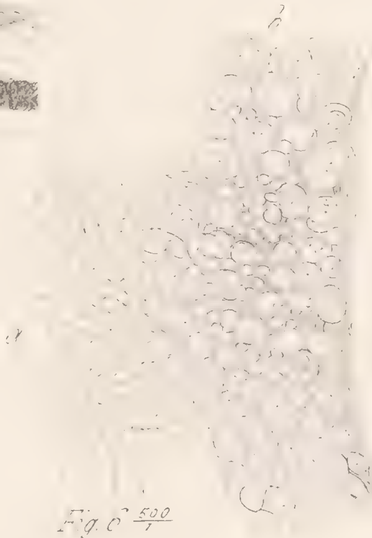

Fig. 6. $\frac{500}{1}$

H. Knapp del. J. Maisonneuve lith.

TWO PECULIAR CASES OF SARCOMA OF THE CHOROID.

By Dr. E. WILLIAMS, of Cincinnati,

and

H. KNAPP, of New York.*

(With Plate B.)

Case I.—*Sarcoma of the Choroid, with Infection of the Retina and Dissemination of Germs from the Degenerated Retina upon Healthy Portions of the Choroid.*

A woman, æt. about 40 years, had in December, 1870, an attack of inflammation of the eye, lasting a few days and leaving the vision permanently and seriously impaired. From that time she could only see to walk about with it. On the 6th of August, 1872, the eye and face became extremely painful and the remaining vision vanished in a few days. From this time the neuralgic paroxysms continued and increased in severity, until they became most excruciating.

About the 25th of November, 1872, she for the first time discovered a little protrusion of the eye. From that time the protrusion increased rapidly, so that on the 3d of December, 1872, when I saw her, the exophthalmus was excessive. The sclerotic was intensely red, lids and conjunctiva much swollen. The sclerotic had become prominent in the upper part of the ciliary circle, giving the globe an irregular egg-shape. On the 4th of December I enucleated the eye and then the tumor, which filled and was moulded in the orbit from the apex forwards, and surrounding the optic nerve, which was in its sheath intact, I easily detached the tumor from the orbit and removed it entire. She recovered very rapidly, and seemed quite improved in health in three or four days. Since that time I did not see her again till December 29th, 1872, when she returned, suffering severely with pain in the head and down the spine, and a reproduction of the tumor of the orbit, which is evidently larger than the

* The history of the first case is by Dr. E. W., that of the second by his partner, Dr. S. C. Ayres; the anatomical examination of the specimens by Dr. H. K.

one I removed about three weeks ago. It has been an unexpectedly rapid reproduction.

The patient died about two months afterwards.

Macroscopic Examination of the Specimen.

The specimen preserved in Müller's fluid presented an eyeball of ordinary dimensions and shape with an *episcleral tumor* reaching from the optic nerve entrance outward nearly to the equator, projecting about 5 mm. over the level of the sclerotic. In addition to it an *orbital tumor*, the size of a small hen's egg, accompanied the specimen. On one side of the orbital tumor lay a portion of the *optic nerve*, 23 mm. in length. Its end corresponding to the sclerotic was considerably enlarged. About one-third of its transverse section was blackish, discolored. Its sheath, in about two-thirds of its circumference and 5 mm. in length, was thickened and in connection with the orbital tumor. Its end, corresponding to the optic foramen, appeared normal. The *orbital tumor* itself was coherent, soft in most places, but somewhat harder, nearly to the consistence of cartilage, in others. Its surface was slightly uneven, indicating an agglomeration of smaller nodes, which were exhibited also on the cut surface. A meridional section, made with a razor through the optic nerve, the episcleral tumor, and the centre of the cornea, presented the following conditions:

The *retina* (Tab. B, Fig. 1, *r*) was detached in its whole extent and stretched, like a folded band, from the posterior capsule of the lens to the entrance of the optic nerve. The vitreous chamber was filled with liquid. In some places (Fig. 1, *n*) the retina appeared black, uneven, thickened, as if studded with small roundish tumors; in others it was thin and uniformly white.

The choroid, ciliary body, iris, and lens were in their proper places. A soft, roundish, partly white and partly black tumor (*t*), intimately connected with the sclerotic, was situated between the optic disk and outer parts of the equatorial region, and projected, with an undulating surface, 3–7 mm. into the vitreous space. Its anterior boundary passed uninterruptedly into the thickened choroid, its posterior boundary was united with the entrance of the optic nerve, which it surrounded nearly in its entire circumfer-

ence, but reaching about 2 mm. beyond its margin on the nasal side. Its anterior surface was smooth, and had an extent of 15 mm. in diameter. Its periphery passed imperceptibly into the adjacent choroid, which could be easily raised from the sclerotic, and appeared of normal thickness. The lamina fusca showed nothing unusual, but the *inner surface* of the choroid was densely covered with small, round, flat or hemispherical, white protuberances, the largest of which had no more than the size of a millet-seed (*p*). Another remarkable condition in this eye was a *thickening of the whole ciliary body*, its elevation (*c*) over the level of the sclerotic amounting, at an average, to 2 mm.; its surface was slightly nodular, black, with numerous white patches. This intumescence occupied only the inner portion of the corpus ciliare, being *separated by a black line from the ciliary muscle* (*m*), which appeared unchanged.

The sclerotic, between the intra-ocular and episcleral portions of the tumor, showed no interruption on the cut surface, but was thinned and evidently split in one place (*s*), the laminæ being crowded asunder by a grayish substance, looking like a part of the tumor, and indicating the *passage* of the intra-ocular pseudoplasm obliquely *through the fibre-bundles of the sclerotic.*

The *episcleral portion* of the tumor offered moderate resistance to the touch, was grayish in its inner, but white in its outer layers, and was pervaded by whitish lines, which here and there connected with the sclerotic.

Microscopic Examination.

The different portions of the tumor presented the same structure, *i.e.*, that of a *melano-sarcoma.* Round cells (Fig. 2, *A*) prevailed over spindle-shaped forms (Fig. 2, *B*). The cells were of medium size, had large dotted nucleoli, and lay closely together. The intercellular substance was finely granular. Brown pigment was scattered in the usual irregular manner through the whole pseudoplasm. It was found (Fig. 2, *A*) both as *molecules* irregularly dispersed through the tissue, or enclosed in smaller and larger cells, and as *small disks*, the size of red blood-corpuscles, lying either free among the other structural elements of the growth, or embedded in the protoplasm of larger sarcoma-cells—cells containing pigmented blood-corpuscles—(Fig. 2, *A*, *a*).

Numerous blood-vessels and hemorrhages were seen in the tumor.

The *passage* of the intra-ocular growth *through the sclerotic* was nicely traceable; rows of sarcoma-cells crowding in different directions between the loosened fibre-bundles of that membrane. The *ciliary body* was completely disorganized by the pseudoplasm. The *ciliary processes* (Fig. 1, *c*), the swelling of which was so conspicuous to the naked eye, were replaced by a dense accumulation of sarcoma-cells. The *ciliary muscle* (Fig. 1, *m*), which macroscopically appeared normal, showed a dense infiltration of cells, between which passed parallel and irregular tracts of connective-tissue fibres. The *choroid*, apart from the tumor, was healthy, except where the *miliary white deposits* (Fig. 1, *p*) were seen. These deposits were sarcoma nodules, and could be traced with the microscope to their smallest origin. In the layer of the pigmented epithelium there were seen numerous round or oval diminutive sarcoma nodules, strewn at smaller or larger intervals of space over the inner surface of the choroid. The smallest of them consisted of two or three cells, which, however, were of the same size and appearance as the cells of the large tumor. In transverse sections of the choroid the accumulations of the sarcoma-cells were found to be *between the epithelial and hyaline layers* (Figs. 3 and 4). Their majority constituted hemispherical or oblong elevations with well-defined outlines (*Fig.* 4, *n* and *Fig.* 3, *m*). Seen from the surface they appeared as round or oval white patches, surrounded by a wall of pigmented epithelial cells of the choroid. They showed the same kind of cells as the original tumor. In other places several rows of sarcoma-cells lay between the hyaline and pigment layers of the choroid (Fig. 3, *o*). The *episcleral* and orbital portions of the pseudoplasm discovered the same structure as the intra-ocular tumors.

The peculiar elementary parts of the *retina* were totally replaced by those of the sarcoma, which in some places were supported by fibres of connective tissue, in others lay closely together in a homogeneous basis substance. This condition was marked especially in nodules with which the corrugated retina was densely studded (Fig. 1, *n*). The boundary of these nodules was formed by cells which showed no stronger cohesion be-

tween one another than the homogeneous basis substance could give them, presenting the same picture as the small denuded nodules on the inner surface of the choroid (Fig. 4, *n*). The cells penetrated for a considerable extent into the optic nerve, behind the eye-ball. A distinct boundary between the origin of the corrugated and degenerated retina and the intra-ocular sarcomatous tumor which encompassed it could not be detected.

REMARKS.—The specimen just described presents a new feature concerning the propagation of intra-ocular sarcoma, viz.: the *occurrence of secondary tumors by dissemination of germs from a remote tissue.* Let us try to trace the development of the whole growth. We must consider the choroidal portion (Fig. 1, *t*) as the primary tumor, which by immediate extension invaded the retina in the neighborhood of the optic papilla, which is encircled. The retina became totally detached and degenerated. From its ciliary part, in which inflammatory and other processes of proliferation are known to be very active, the elementary parts of the pseudoplasm extended into the adjacent ciliary body, and finding there a favorable soil, multiplied abundantly, destroying, as everywhere, the tissue which they invade. This accounts for the thickening and degeneration of the ciliary body.

The small isolated sarcoma nodules on the inner surface of the otherwise healthy choroid cannot owe their origin to immediate extension of the original choroidal pseudoplasm, nor is it likely that they received their first cells from the retina when the retina was still in contact with the choroid. A migration of sarcoma-cells from the original tumor would have shown tracks of cells between the fibres of the choroidal tissue, as we can trace them so nicely across the sclerotic. Our specimen, however, showed no vestiges of such cells between the secondary clusters in and under the epithelial layer and the original tumor, which developed and remained in the stroma of the choroid. Had they sprung from the retina, while the retina was still in contact with the choroid, it is probable that the retina would not have been detached at all, but, in these places at least, would have remained agglutinated to the choroid, the new growth itself acting as a cement or a connecting link. The only plausible way in which to account for the occurrence of these isolated clusters is

the following: From the nodules of the retina, cells were detached, fell into the liquid between the retina and choroid, and were deposited on the pigment layer of the choroid. Here they took root, and, as they depended for their nutrition on the chorio-capillaris, it is not strange that they penetrated the epithelial layer, but were arrested by the hyaline membrane which separates the epithelium from the capillary layer of the choroid. In their further proliferation they expanded between these two strata, raised and perforated the epithelial layer, and grew into the posterior space of the eye. Virchow has described this mode of propagation of tumors as dissemination of germs. In the eye I have observed and described it for the extension of glioma of the retina to the choroid (Intra-ocular Tumors, p. 30, etc., and Figs. 6 and 7, Tab. III.).

For intra-ocular sarcoma this is the first observation. It is noteworthy that the seminium from which the seeds were strown out was found, not in the choroid, but in the retina. To support this view, I add that the surface of the primary choroidal tumor was throughout smooth and covered with epithelium, nor was there an exulcerated place seen on the ciliary processes, whereas the retina appeared denuded in many places, especially at the apices of the small nodules.

Case II.—*Melano-Sarcoma of the Choroid extending to the Retina and Optic Nerve.*

For the specimen, which is the subject of this observation and the notes on the history of the patient, I am likewise indebted to Dr. E. Williams, of Cincinnati, and his partner, Dr. S. C. Ayres. It was taken, by way of an ordinary enucleation, from Miss Eliza J. Folk, a tall, anæmic girl, 12 years of age, at the beginning of May, 1873. She said that she did not discover that the eye was blind until about two years and a half ago, when she accidentally injured the other—left—eye. She suffered no pain until within the past year. During the last months she had several attacks of severe pain in the eye, which would generally last about a week. Her health during the last year had failed rapidly. She had several hemorrhages from the lungs, and there is a deposit of tubercles at the apex of the right lung. Her mother is living, but her father died of consumption.

When she applied for advice, the iris of the blind right eye was found very much discolored, with complete posterior synechiæ. The lens was opaque and greenish. The tension of the globe decidedly increased (T_1). As

the fundus could not be seen, an intra-ocular tumor was suspected, enucleation was advised, and shortly after performed without difficulty. Immediately after the removal of the eye, Drs. Williams and Ayres examined the optic nerve, and finding it enlarged and reddish, they seized and excised as large a portion of the nerve from the orbit as they could draw forward. The patient went home on the fourth day after the operation.

Anatomical examination of the specimen.

The eye-ball, hardened in Müller's fluid, was opened by a circular section in the equatorial plane. The retina (*r*, Fig. 5) was detached from the choroid, but adhered to the optic disc (*o*) and to the ciliary body at the ora serrata. It was folded, enclosing, however, a considerable space filled with gelatinized vitreous humor. The lens was in its proper place, and apparently normal. Near the optic disc was a hardish tumor (*t*, Fig. 5), the size of a cherry-stone, connecting with a broad base to the choroid. The surface of the tumor was white and slightly rough. A portion of the detached retina is covered on its outer side with a thin coat of the same substance as that on the surface of the tumor. It is evident that in this place, the retina (r_1) had been united to the tumor, and was torn from it when the eye-ball was opened. The choroid and the other parts of the eye-ball discovered nothing abnormal.

A transverse section through the tumor (Fig. 5. *t*) showed a granular white surface with a few black dots. The base of the tumor extended into the choroid in the form of a wedge-shaped zone (*a*), about 5 millimetres in breadth. The tumor overlapped the optic disc (*o*), and raised and folded the retina by which (r_1) it was partially covered. The tumor was so loosely united to the sclerotic, that it could readily be detached from it.

Under the microscope the structure of the tumor was composed of a scanty matrix, round and spindle-shaped cells of varying size, and the spindle-shaped elements prevailing. Brown pigment was found here and there in irregular forms between the white sarcoma cells, or embedded in the protoplasm of larger cells. Its origin from the blood was evident, from the round little discs in the protoplasm, the size of which was that of red blood-corpuscles, and their color varying from the ordinary yellow tint of the blood-discs to a deep red-brown. The prolongation of the base of the tumor

(*a*, Fig. 5) wedged itself into the choroid, between the layer of the larger blood-vessels and the epithelial layer, as is usual. The remaining portions of the choroid, the ciliary body, iris, lens, and corneo-scleral capsule of the eye showed no abnormity worth mentioning. The *retina* was densely infiltrated with sarcoma cells throughout its whole extent. The columnar layer was not seen; the outer layers were totally replaced by round and spindle-shaped cells lying closely together. Of the inner layers, only the bundles of radiating fibres were partially preserved. The inner and outer limiting membranes enclosed, however, the invading elements in such a way that the ordinary aspect of the retina was unaltered. But in its most anterior part the retina presented important changes under the microscope. Transverse sections (Fig. 6) showed all the layers replaced by sarcoma cells (*b*), and here and there were small *excrescences* (*a*, Fig. 6) of the pseudoplasm in which spindle-shaped cells and small and large round cells grew without a trace of a boundary-line over the surface of the degenerated retina. The end of the retina at the ora serrata was more swollen than it is in the normal condition. The ciliary part of the retina was well visible and showed no changes. The end (*o*, Fig. 5) of the optic nerve which was contained in the specimen, showed in sections taken from its outer surface, only a scant infiltration of the fibre-bundles and the interstitial connective tissue with round sarcoma cells, whilst in sections taken near the origin of the retina, the foreign elements were densely accumulated, and had destroyed the nervous fibres.

Remarks.—The case just described is interesting in several points of view.

1. *The age*—22 years—of the patient affected with a choroidal sarcoma which showed a marked beginning of pigmentation, is unusually young, only a few cases of choroidal sarcoma of that age being on record.

2. The *origin* and early *development* of the growth were free from pain and inconvenience; the patient discovered accidentally that the eye was blind, and had no pain from it until 18 months later. The second, or glaucomatous stage of the disease, set in when the eye had been known to be blind for fully two years.

3. The patient was *tuberculous* and of a tuberculous family,

showing that there is no exclusion between tubercles and sarcoma, more especially between tubercles in the lungs and melano-sarcoma in the choroid.

4. The sarcoma *originated in the vicinity of the optic disc, overlapped the disc* in its growth, folded the retina up, and detached it from the choroid in its whole extent, but *remained itself partially covered by it.*

5. The *close contact of the sarcoma with the retina* and optic nerve, explains its extension to these parts by *immediate propagation.*

6. It is remarkable that the infiltration of sarcoma cells did not reach beyond the retina proper, the pars ciliaris being free.

7. At the anterior part of the retina, the foreign elements formed *excrescences and little tumors with a free surface.* It appears plausible that the cells on the free surface of these tumors may, by contact, transfer the morbid action to the neighboring parts, as we have seen in the ciliary body of the foregoing specimen, or that such cells may be detached from the free surface of the excrescence, fall through the subretinal space on the inner surface of the choroid, and there form secondary growths. The retina, with its excrescences or small exulcerating tumors, may become the seminium of isolated secondary choroidal tumors, as we have likewise seen in the preceding case.

8. The present case represents many analogies with the former, of which it may be considered as a lower stage of development.

THREE CASES OF TENOTOMY OF THE SUPERIOR AND INFERIOR RECTI, WITH COMMENTS.

BY H. KNAPP.

TENOTOMY of the superior or inferior rectus muscle is seldom performed. The text-books say almost nothing about it. *Von Graefe* seems to be the only author who has dwelt on this subject at some length, especially in his paper, entitled, Aphorisms on Tenotomy, with particular reference to Paralytic Diplopia (*Zehender's Klinische Monatsblatter*, *year* 1864, pp. 1–22). This paper was the publication of two of his admirable clinical lectures; it contains many judicious remarks and useful rules, evidently derived from Graefe's vast experience, but not supported by the history of cases. Though the records of cases may be tiresome, yet they are the only thorough basis for arguments and rules. I think, therefore, that the discussion of the three following observations may not be without interest.

CASE I.—*Tenotomy of the lower and upper recti of the same eye for paresis of the upper rectus.*

The left eye of Miss Anna D., of P——, N. Y., suffered in her childhood from extensive paralytic affections. In the course of years, without any special treatment, the stiffness and deviation of the eye gradually subsided. The right eye has never manifested any anomaly of motion.

When the patient came to consult me in the spring of 1872, she unintermittingly held her head backward, which gave her a conspicuously stiff and affected appearance. The left eyeball was slightly protruding, and the palpebral fissure a little larger than on the other side.

On examination, I found the following condition: Both eyes had $S=\frac{20}{30}$, improved by —40 cyl., axis horizontal, to $\frac{20}{20}$. In the interior, nothing abnormal. The lateral and downward movements of both eyes were regular and harmonious. In upward movements, however, the left eye lagged behind, beginning to be perceptible in the horizontal plane and increasing at the greatest elevation to about 3 millimetres. When the right eye was covered, and the left looked at an object in the upper half of the visual field, the right eye behind the covering hand squinted up-

ward. There was single vision from a plane about 10° below the horizon, down to the limits of the field of fixation. Above that plane there was marked diplopia. The double images showed pronounced differences of height, but their lateral deviations and their want of parallelism were small and inconstant. Of the results obtained by the examination with prisms, the following two seemed of importance: When a prism of ten degrees was placed before the left eye with its base upward, there was single vision in the whole lower half of the field of fixation, and even some degrees above the horizontal plane. When a prism of ten degrees was held before the left eye with its base downward, there was diplopia everywhere.

From these observations I derived the following conclusions: There was in early life, perhaps congenital, paralysis of the left oculo-motor nerve. Its cause was unknown, as neither parents nor child showed any symptoms of a constitutional disease. Recovery took place in all the branches of the oculo-motor nerve, except those supplying the elevator muscles: rectus superior and obliquus inferior, and even this remnant of the paralysis was incomplete, as the eye could be raised considerably above the horizon. The second experiment with prisms showed that the superior rectus, or rather the elevator pair, though stimulated to moderate movements by forcible elevations of both eyes, was inert whenever its service was required for the purpose of binocular single vision. The first experiment with prisms showed that the action of the inferior rectus, or rather the depressor pair, was pre-eminently governed by the binocular single vision. In the whole sphere of its action it made a forced contraction, equivalent to the effect of a prism of ten degrees, to keep up single vision.

This experiment rendered me confident that a tenotomy of the inferior rectus might safely be tried. If, in the service of single vision, that muscle which is the predominant muscle in the depressor pair, contracted to the effect of a prism of ten degrees, it seemed natural and in conformity with experience that, after a tenotomy not exceeding the effect of a prism of ten degrees, its contraction would still be sufficient to secure single vision in the greater part of the lower half of the field of fixation. Though the young lady used her eyes without fatigue and annoyance of any kind, yet her habit of throwing the head back was so strange, unconventional, and provoking the mockery of her ungener-

ous acquaintances, that I advised her to undergo the operation.

She consented, and I made a simple. subconjunctival tenotomy of the left inferior rectus, without anæsthesia. on June 22d, 1872. When she had recovered from the immediate effect of the operation, there was single vision in the whole upper half of the field of fixation. and five degrees below the horizon, farther down there was diplopia. and the left eye lagged behind. When I saw the patient in the evening, five hours after the operation, there was no irritation in the wound, and the separating line between single and double vision had risen to the horizontal median plane. During the next days the wound healed nicely, but the field of vision did not extend. In the course of the following weeks it extended somewhat downward, but ultimately returned to the horizontal median plane.

The effect of this operation was far greater than I had anticipated; it surpassed what I could reasonably expect. The rule is, that the immediate effect of a tenotomy, if the antagonist is paretic or paralytic, increases some days after the operation, but diminishes greatly during the subsequent months, in some instances so much as almost to disappear altogether. According to Von Graefe's statement (*l. c.*) and my own experience, this holds good for the tenotomy of the superior and inferior recti, as well as the lateral muscles. Von Graefe lays down the following rule: When a superior or inferior rectus is paretic or paralytic, divide its partner in the other eye, and if the effect proves insufficient, divide also its antagonist in the same eye. Had I followed this rule in the case under consideration, both superior recti would have been weak, and the diplopia in the upper half of the field of fixation would have been removed. In the lower half single vision would probably have been preserved, as both the inferior recti were muscles of normal and equal strength, and had equally weak antagonists. This plan would certainly have been preferable, had the only object of the operation consisted in the removal of double images, the object which Von Graefe had in view above all others. In paralysis of the inferior rectus, on which V. Gr. mainly dwells, the double images are in the lower half of the field of vision, and exceedingly embarrassing. Their removal is, therefore, of paramount importance. In

our case the object of the treatment was the cure of a false position of the head, evidently occasioned by double images in the upper half of the field of fixation. A tenotomy of the superior retcus of the healthy eye would have removed the double images, but introduced another cause of the reclination of the head, together with a forced raising of the upper eyelids, namely, the weakness of both superior recti. To judge from the false position of the head with which we are so familiar in lateral squint, the weakness of the superior recti, in the case under consideration, could not but be counterbalanced by a forced reclination of the head. The object of the treatment, thus, would have been missed. That object, to obviate the reclination of the head, was attained by my operation, but unfortunately it threw the patient from Scylla into Charybdis: instead of reclining, if she wished to see single, she now had to stoop, and this stooping could not be done without a great effort, the diplopia occupying the whole lower half of the field of fixation. From an awkward, but not annoying attitude, she was thrown into a most uncomfortable, embarrassing position: the objects on the floor, spoon, plate, knife and fork on the table, pen and paper, everything appeared double. In this condition the young lady lived a whole year. I saw her from time to time, watching whether the range of single vision would not increase in her case, as in most others. It did not increase. She held her head straight, as other people do, but the diplopia continued annoying, and often compelled her to close one eye.

In May, 1873, she consulted me again. There was no change in the condition of her eye. What was to be done? According to the principles laid down by Von Graefe, I had to divide the inferior rectus of the good eye. This would have established equilibrium, but I disliked the idea of weakening the two inferior recti, the services of which are constantly required. Even if they could be weakened in the same degree, so as to render their associated action easy and harmonious, a certain habit of stooping would have been the unavoidable consequence. One thing struck me favorably in the analysis of the case: the previous operation had rendered all its normal energy to the superior rectus, which muscle had so long been out of use, and could neither by prisms, nor in any other way be stimulated to act in the service of binocular

vision. Now it worked in harmony with the other superior rectus, and double images became at once apparent when a prism was held in any direction before either eye. The return of binocular vision in the whole field was the great gain of the operation and a year's trial. Upon it I based my judgment concerning further interference. The upward movements of the eye were as extensive as those of its fellow ; there was no longer any paralysis of the superior rectus. The downward movements of the left eye were diminished, and a keen perception of diplopia existed. The operation had not reduced the mobility of the eye, it had only displaced it, and there was a range of mobility large enough to afford comfortable binocular single vision for all purposes, if its field could only be shifted down to the proper place. Not seeing an insurmountable difficulty in effecting this by an operation, I advised a tenotomy of the left superior rectus, the previously paretic muscle.

In order, however, to make sure against any unforeseen results, either too great or too little, I performed the tenotomy at 9 o'clock in the morning, without anæsthesia, and kept the patient under observation the whole day. I operated cautiously, at first dividing, subconjunctivally, the greater part, probably the whole tendon. This operation brought the lower limit of the field of single vision to about 15° below the horizon. Thinking this effect too small, I loosened more of the subconjunctival tissue around the insertion of the tendon, till the lower limit of the field of single vision was 25° below the horizon, and their upper limit 15° above it. Within that range, single vision existed without any annoyance ; reading and writing was done easily, and there was nothing strange or forced in the position of the head. This condition being very satisfactory, I carefully watched its continuance during the day. It did not materially change, and remained stationary for a few days more, but afterwards there was a steady increase of the field of single vision. When I saw the patient for the last time, on Aug. 4th, 1873, 10 weeks after the operation, she had binocular single vision from about 35° below the horizon to about 25° above it, and could use her eyes without fatigue or inconvenience. She was completely satisfied with the result of the operation, and so was I.

Had it been possible to obtain this result by a more careful operation the first time? I think so, and shall in future avail my-

self of this experience. If I have the choice of time, I shall make tenotomies of any kind in the forenoon, and watch and eventually correct the effect during the day. Furthermore, I shall not rely any longer on the rule that, when the antagonist is paretic, the ultimate effect of the operation will be much less than the primary. Prior to any operation, I shall always endeavor to determine how the eye should be directed and move during the first day, and I shall not consider the operation terminated before this result has been obtained and continued stationary for some hours. This rule is not new, either to me or to others, but the case just described may serve to emphasize it.

CASE II.—*Tenotomy of the external rectus of both eyes, and the inferior rectus of the left eye, for strabismus and diplopia.*

The following case presents a somewhat complicated therapeutical problem, the practical interest of which is enhanced by the success of the treatment:

On the 15th of Sept., 1873, a healthy young man, J. W. Th——, of Alleghany, Pa., æt. 19, consulted me on account of his eyes. There was a concomitant divergent strabismus of three lines in the right eye, and the patient complained of constant and annoying double-seeing. He could not recollect when the diplopia and squint had begun; he thought they might have existed all his life, though during the last years his eyes had annoyed him so much, that he would try everything to have them cured. On examination, I found the field of fixation of either eye normal, but there was pronounced crossed diplopia. Both eyes were hyperopic of $\frac{1}{30}$, the right had S $\frac{20}{40}$, the left S $\frac{20}{20}$. The ophthalmoscopic conditions may be described as choroiditis atrophica disseminata and retinitis plastica of the right eye. There were irregular yellowish patches dispersed over the whole fundus, exhibiting the usual picture of superficial choroidal atrophy. On the optic disc lay a ring-shaped plastic exudation like a thin skein of snow-white cotton. Its inner and lower parts reached the margin of the papilla, but its outer and upper parts remained somewhat—about $\frac{1}{6}$ P (diameter of papilla)—distant from the margin of the disc, and expanded into a thin white membrane, passing in a radiating direction over the border of the nerve and fading away in the adjacent retina. This white ring lay partially before and partially behind the retinal vessels. From the reflex surrounding the yellow spots, thin and short white lines radiated in all directions. Longer white streaks, dividing like the branches

of a tree, passed irregularly through different parts of the retina, intersecting and covering the retinal vessels. In the left eye there was no abnormity other than a membranous cobweb-like opacity in about the centre of the vitreous. Cylindrical glasses did not improve the sight of the right eye.

Regarding these changes to be either congenital or of old date, in any case perfectly confirmed, the therapeutical problem I had to solve was the removal of the squint and diplopia. This I thought to accomplish by a tenotomy, first of the right, and soon after of the left external rectus.

I made a free division of the right external rectus on September 19th. Two days later, the mobility was so far restored that the margin of the cornea approached the outer commissure by one line. There was a divergence of one line left, complicated with a marked deviation downward and outward of the closed left eye, and upward and outward of the closed right eye. There was diplopia in the whole field of fixation. The image of the right eye was lower, nearer to the body, on the left side of the image of the left eye, and inclined with its upper extremity to the left side. When the base of a prism of 9° was held toward the nose, the slanting image of the right eye crossed the straight image of the left. These conditions remained unchanged the next day, the third after the operation.

What diagnosis could be derived from the symptoms just described? The divergent strabismus was still the predominant symptom, but the pronounced deviation of height, the considerable slanting of the pseudo-image, and the secondary diagonal deflection of either eye could not be the consequence of simple, *i. e.* uncomplicated divergent strabismus. I could, therefore, no longer expect to cure the difficulty by the tenotomy of the left external rectus alone. This operation was likely to remove the lateral distances of the double images, but not the differences of height nor the slanting. For these deviations I had to find the cause, and, if possible, the remedy. No deficiency of mobility in any direction could be detected; any kind of paralytic affection, complete or incomplete, had, therefore, to be excluded. The associated motions of both eyeballs being of the same direction and extent, the characteristic symptoms of concomitant strabismus were present. By the primary and second-

ary deviation, *the strabismus was determined as being in the right eye, and, with regard to its direction, diagonally outward and upward.*

The cause of this kind of squint could not be an anomaly of refraction, since the slight degree of hyperopia predisposed the patient to convergent, not divergent squint. The deficiency of sight in the right eye, produced by choroido-retinitis and its consequences, might fairly be regarded a cause of strabismus, but in itself alone, and aided by the hyperopia, would have occasioned a tendency toward convergence. The previous existence of a paralytic affection alone could satisfactorily account for the present conditions. The quick and constant perception of double images was a strong argument in favor of this hypothesis, since diplopia is commonly absent or little pronounced in refractive strabismus of long duration, whereas it remains vivid in paralytic strabismus a whole life-time. There was, probably early in life, a paralysis of the right oculomotor nerve, the recovery of which was tardy in the branches innervating the inner and inferior recti. During the period in which these two muscles were paralyzed, their antagonists became strengthened and assumed a certain degree of increased contraction, which remained permanent after the paralysis had disappeared. The case then ranks with those known under the name of paralytic strabismus. It showed, in the right eye, a constant deviation outward and upward, and the slanting to the left of the heteronymous pseudo-image, indicated an abnormal outward inclination of the upper end of the vertical meridian of the right eye, or, according to recent researches, a positive rotation of the eye on the visual axis where there should be a negative one. All these deviations could be explained by increased action of one muscle, the *right inferior oblique*, which turns the cornea upward and outward, and the upper end of the vertical meridian outward. The divergence, however, was so great, that it could not have been caused by a contraction of the inferior oblique alone, but the external rectus was likewise contracted.

The *therapeutical indications* had to meet the following condition: 1, a marked divergence, and 2, a less marked elevation of the right eye, and 3, a pathological divergence of the upper ends of the vertical meridians. A tenotomy of the right inferior ob-

lique muscle would have removed the deviations of height and the divergence of the meridians. This operation, however, has never been made, and though I think that it is not impossible to divide this muscle somewhere in its course, perhaps best near its origin at the lower margin of the orbit, there was another expedient likely to fulfil all the indications. The remainder of the divergence could be fully corrected by a tenotomy of the *left external rectus.* The difference of height and the slanting of the pseudo-image could both be corrected by a cautious tenotomy of the *left inferior rectus.* In reversion to the physiological action of this muscle, its division must place the cornea higher, somewhat outward, and turn the upper end of the vertical meridian inward. The parallelism of the meridians could thus be restored. The eversion of the eye resulting from the reduction of the weaker component of the inferior rectus could easily be counterbalanced by the tenotomy of the external rectus.

According to this operative scheme, I first made a complete division of the tendon of the *left external rectus.* This placed the equilibrium of the lateral muscles to an object of fixation at a distance of one to two feet, that is, the double images were vertically above each other when the candle was held one or two feet from the eye. But now the differences of height became more conspicuous and troublesome. When he read, he saw two sets of print, the one seen with the right eye was below the other seen with the left eye, and ran obliquely from above and left to below and right at an angle of 22°, according to the patient's drawing.

In order to remove this slanting and the difference of height in the pseudo-image, I divided the tendon of the *left inferior rectus.* The hook was introduced through the same conjunctival wound which had served for the division of the external rectus. When about half of the tendon was divided, I examined the condition of the double images. Finding that still a marked difference of height existed, I reintroduced the hook, and severed another portion of the tendon, and then a third and a fourth one, always examining the effect produced by these partial divisions on the double images, till I found that an object was seen single when held in the median plane, one foot and a half from the eye, and about 20 degrees below the horizon. The tenotomy was subconjunctival and either complete or almost complete. The patient was sitting on the operating chair during the whole operation, which, however, did not last much longer than an ordinary tenotomy. When examined immediately after the operation, looking at an object, situated in the median plane 20° below the

horizon, $1\frac{1}{2}'$ distant from the body, the eye was at a level with its fellow, and there was no deviation, either actual or dynamic. The outward motion of the eye was moderately reduced, the downward motion only slightly. An hour after the operation, the field of single vision had extended about 40° laterally, and 10° vertically; six hours after the operation it extended about 45° laterally and 18° vertically.

There was a considerable effusion of blood under the conjunctiva and some pain during the first twelve hours after the operation. Since then the eye has been free from pain, and the effusion of blood was rapidly reduced. Twenty-four hours after the operation, the upward and downward motions of both eyes were uniform and equal, except that the left eye lagged a little behind in the extreme downward motions. Greatest abduction approached either eye to a point $1'''$ distant from the outer commissure, whereas, both corneal margins touched the caruncle on greatest inversion. Two days later, the patient returned home, perfectly satisfied. He could read, walk, and do any kind of work without double seeing, or any other annoyance. The field of single vision now reached about 10° above the horizon, and nearly to the natural limit below. Laterally is extended about 50°. He wrote me at the beginning of February, 1874, five months after the operation, that the condition of his eyes was satisfactory. The squint was removed, and by continued exertions he could make objects unite in places where, after the operation, they still appeared double.

CASE III.—*Strabismus sursum vergens, improved by tenotomy of the superior rectus with a suture, increasing the effect, through the lower lid; cured by advancement of the inferior rectus.*

In the following case a conspicuous disfigurement, without diplopia, induced the patient to request surgical interference:

He was a healthy man, of 29 years of age, of New York City. He remembered that he saw double when a child. Seven years ago he first noticed that his left eye had an upward turn, which kept slowly increasing for three years. Since then, the eye has not changed its position. When the deviation had set in, he saw double for three months, not afterward. On examination, April 30th, 1873, I found E. and S. $\frac{20}{20}$, in either eye. When he looked straight forward, the left pupil was about six millimetres above the level of the right. This difference in height diminished when he turned his eyes upward, but even in the greatest elevation his right eye remained two millimetres lower than the left. Greatest adduction carried the corneal margin a little under the caruncle, greatest abduction

to a point two millimetres distant from the outer commissure. The limit of the downward movements represented a line running obliquely from above and outward to below and inward. When he looked outward and downward, the corneal margin did not move below the horizontal middle line of the palpebral fissure; when he looked straight down, the corneal margin reached the border of the lower lid, and when he looked down and inward, the margin of the cornea went two millimetres below the free edge of the lower lid. There was no diplopia, either spontaneous or by prisms and colored glasses. Nothing abnormal in the fundus.

The diagnosis of this case, too, was paralytic strabismus. There was still a marked defect of mobility, greatest outward and downward, least pronounced inward and downward. The paralytic muscle belonged to the depressor pair; inferior rectus and superior oblique. The inferior rectus turns the eye downward with its greatest energy when the line of fixation is directed 21° outward. The more the line of fixation is turned inward, the less the depressing component of the inferior rectus, and the more its rotating component come into play. When the line of fixation is directed down and inward, the superior oblique has a marked effect in lowering the cornea, whereas it has but very little influence on the level of the cornea when the line of fixation is directed down and outward. The peculiar defect in the field of fixation of the left eye in the case under consideration, running from below and inward to above and outward, could thus be satisfactorily accounted for as resulting from a paralysis of the inferior rectus alone, leaving the energy of the superior oblique undiminished. Had the patient preserved binocular vision, the diagnosis would have been strengthened by the peculiarities of the double images. The defect of motion, however, was sufficient in itself to establish it correctly. There was not only paralysis of the main depressor oculi, but increased contraction of the "*par elevatorum oculi:*" the superior rectus and inferior oblique.

The *therapeutical problem* was to lower the cornea to its natural level. Double images did not complicate its solution unless, as is the case frequently enough, they appear after the tenotomy, though they could by no means be made perceptible before the operation. Several ways seemed open to effect a cure in this case of paralysis and squint. 1. Tenotomy of the partner of the

paralytic muscle, the inferior rectus, in the healthy eye ; 2. Tenotomy of its antagonist, the superior rectus, in the same eye ; 3. These two operations combined, if one should prove insufficient (Von Graefe) ; 4. Advancement of the inferior rectus combined with tenotomy of the superior rectus, in the deviated eye.

I first made an extensive tenotomy of the superior rectus of the squinting eye, and increased its effect by a suture which was passed first through the conjunctiva, below the cornea, including as much subconjunctival tissue as the needle would grasp, and secondly, through the lower lid at its reflection on the globe. A thread, armed with two needles, was employed for this purpose. One needle was passed through the conjunctiva of the globe and through the lid, the other through the lid only, both emerging on the outer surface of the lid, about four lines below the ciliary edge. The ends of the thread were tied over a thin tent of lint. The eyeball was so much drawn down, that half of the cornea was covered by the lower lid.—(A thread armed with one needle might have answered the purpose as well. The needle in that case would have pierced first the lid from the skin towards the conjunctiva, then the conjunctiva of the globe, and lastly, the lid again from the conjunctiva toward the skin.)

No notable reaction followed ; the thread was cut two days after the operation ; the left eyeball was two millimetres higher than the right, instead of six, as before. This effect, however, diminished gradually, and in six weeks after the operation, the eye was four millimetres higher than its fellow, with a tendency to further elevation.

This retrogression, though not unexpected on account of the inert inferior rectus, surpassed my anticipation by its high degree. All my endeavors to produce an effect as large as possible by an extensive tenotomy and tying the eye down to the lower lid with a suture had corrected only one line, a third of the original deviation. The paralytic muscle, during the weakness of its antagonist, had not been stimulated to regain power. In this respect, the case under consideration contrasts with the first case described above, in which the paretic muscle had regained its full energy after the division of its antagonist. We must not forget, however, that the muscle, in the first case, was paretic only, whereas, in this, it was totally paralytic. In cases of this latter kind, the ultimate effect of a simple tenotomy is sometimes almost nil. As this cannot always be determined beforehand, and the patient in

the present case lived in New York, an insufficient operation was no injury. Apart from that consideration, I was anxious to try what effect a suture, tying the globe down to the lower lid, might produce.

The next question was: Should I divide the inferior rectus of the right eye? I thought this would probably have an insufficient effect, unless I layered the tendon so extensively back as to cause a marked degree of paralysis. This I wished to avoid, as the patient would have been obliged to stoop almost constantly. No other way then remained than the advancement of the paralytic inferior rectus.

Seven weeks after the first operation, I made an extensive advancement of the inferior rectus, according to Critchett's method, with four sutures, immediately preceded by a second tenotomy of the superior rectus. After the operation, the cornea was three millimetres lower than that of the other eye.

No great reaction followed. The sutures were removed on the third day. The eye was two millimetres lower than its fellow. In the course of two months it rose to the level of the other, and has remained in that position up to this day, five months after the operation. The patient has no double images, and his disfigurement is removed.

The three cases thus were operated on successfully. Apart from the diagnosis, they offered peculiar difficulties as to the choice of the appropriate operative procedures. The effects of the initial steps in the first case and in the third did not answer my expectations, yet they served as useful guides for the further procedures. There being always a good deal of uncertainty in our calculation of the effects of tenotomies in paralytic affections of the eye, we should arrange our operative schemes in such a way as to make the first steps the tests of the reactive powers in the individual cases.

CLINICO-OPHTHALMOLOGICAL CONTRIBUTIONS.

By Dr. LANDESBERG, of Elberfeld.

(Translated by Drs. R. Gebser and F. A. Munson, of New York.)

I.—*Corectopia Binocularis.*

Mrs. B., aged 29, consulted me on the 21st of September, 1871, in regard to her eyes. She appeared robust, and was in the enjoyment of good general health.

Without a close examination the attention was at once attracted by a singular expression of the face, which was rendered more evident when the patient looked straight at me. The expression was one of timidity or sullenness, without which the features would have been quite comely. Upon a closer inspection this strange physiognomy was seen to depend upon a peculiar abnormality of the pupils.

In the *right eye* the pupil is displaced upwards and outwards in such a manner that at the ciliary margin only a small rim of iris is visible. The shape of the pupil is that of an ellipse, somewhat ragged and irregular. The pupil reacts both upon the stimulus of light and with the accommodative movements. The iris is gray, its texture normal, and the sphincter well preserved; it bulges slightly towards the centre of the cornea and is tremulous; the periphery being somewhat retracted, makes the anterior chamber appear deeper at its circumference.

Ophthalmoscopically the refractive media are clear, but the optic papilla is observed very much distorted and the vessels tortuous. The external surface of the globe presents nothing abnormal. On testing the dioptric condition of the eye, a high degree of irregular myopic astigmatism is found, in consequence of which the vision is much impaired.

With the best corrective glass—concave 5—$V = \frac{5}{70}$, and Jäger No. 6 is read fluently, Jäger No. 4 with difficulty. Cylindrical glasses do not improve her sight.

In the *left eye* the pupil has a displacement downwards and outwards, and, like its companion, is separated in that direction from the ciliary margin by a narrow rim of iris. Owing to the existence of posterior synechiæ its outline is irregular and its mobility scarcely perceptible, but upon the instillation of atropine it enlarges so that the papilla can be seen. The iris is of a dull slate color, its tissue appears tendinous and indistinct. There are deposits upon the anterior capsule of the lens, flaky opacities

in the corpus vitreum and several atrophic spots in the choroid, with a partial maceration of pigment cells. The picture is one of irido-choroiditis chronica. The intra-ocular tension is normal, the sight, although quite difficult to determine, is about $\frac{5}{100}$, which with strong concave glasses ($\frac{1}{6}$–$\frac{1}{4}$) is improved to V = $\frac{5}{250}$, enabling the patient to spell Jäger 18. She does not remember to have ever had better vision with this eye, and hence is unable to state when the disease had its commencement.

She refused treatment.

II. *Two Cases of Embolism of the Central Retinal Artery.*

Case I.—N. H., 55 years of age, called on me in the afternoon of Nov. 26, 1870, stating that on awaking the previous morning he found to his astonishment that he was completely blind in his *left eye*, which had always been better than the right. He is positive that the eye lost its sight during the night, as he had read without difficulty before retiring. The patient is stout, plethoric looking, and of the so-called apoplectic habitus; his general health has always been good. and no disease of the heart or blood-vessels can be found.

The external appearance of the affected eye is normal and the cornea and refracting media are clear. The pupil is normal in size and shape, and reacts well on light, but slowly on accommodation. Tn. Central fixation is wanting, but to the extreme outer side V = $\frac{1}{200}$. The field of vision is not definable, and when tested in a dark room the quantitative perception of light exists only in the upper outer quadrant.

Ophthalmoscopic Examination.—The papilla is seen clearly defined and of a pinkish hue; its arteries and those of the retina are small and thread-like—the finer branches being indistinguishable—some of the vessels are not to be traced from their entrance upon the optic disk to its margin, but appear as if originating from the latter point. Slight pressure upon the globe fails to produce arterial pulsation. Comparatively the veins are much larger than the arteries, yet relatively smaller than the veins in the normal eye. Some are irregularly filled towards the periphery, while others are filled and tortuous in part of their course, and then become small and nearly empty.

In the lower part of the inverted image, near the equator, a small, venous varix is observed. The retina is infiltrated with serum, which partially covers the track of the vessels, and is greatest in amount in the vicinity of the macula lutea. The latter can be distinguished as a round spot with a cherry-colored centre and a dark-red border; its inner margin is surrounded by a crescentic aggregation of white dots.

There are five small *ecchymoses* to the nasal side of the papilla as well

as a larger hemorrhage in the inner lower quadrant The *right eye* has M $\frac{1}{10}$, with V = $\frac{15}{40}$ and Jäger No. 4. The cornea is slightly nebulous, but the fundus perfectly clear and normal.

Nov. 28.—Applied two of Heurteloup's leeches and ordered a foot-bath with aqua regia and an aperient.

Dec. 2d.—To the outer side of the visual field S = $\frac{1}{100}$, and the quantitative perception of light to the inner side is regained.

Ophthalmoscop. Ex.—The optic disk is pale and prominent, the arteries thread-like and the veins a little more filled than when first observed. In the upper part of the inverted image, at a short distance from the edge of the papilla, an artery is seen which evidently comes from the disk, but which is so completely interrupted as not to be traced to it. The retinal infiltration is most marked in the region of the yellow spot, and the white dots have increased in number and size.

Dec. 6th.—V = $\frac{1}{40}$, being as before confined to the outer side of the field; in other respects the patient remains in *statu quo.* Applied two Heurteloups.

Dec. 10th.—V = $\frac{1}{20}$ to the outer side only, and patient reads with difficulty Jäger No. 19. The visual field is entirely regained except in a small sector to the inner and lower side.

Ophthalmoscop. Ex.—The papilla is reddish, but not swelled, the veins are normally filled and the venous varix has disappeared. The arteries are larger than before, yet are only about one-half their normal calibre. The obliteration of the vessel, in the upper part of the inverted image, observed on Dec. 2d, has somewhat increased, and the retinal infiltration persists merely at the macula lutea. Apart from these changes no other alterations are discernible.

Dec. 13th.—Two leeches were again applied.

Dec. 16th.—V = $\frac{1}{20}$, but Jäger No. 17 is read with effort. The field for perception of light is good, only a small section to the inner and lower sides being somewhat uncertain.

Ophthalmoscop. Ex.—The papilla is pale, the veins normal and the arteries small, but traceable in all their branches without interruption, except the upper arterial trunk described. The retina is clear, but grouped about the macula lutea there are distinctly defined small round and oval white spots and shining cholesterine-like dots. The former resemble the appearances seen in retinitis albuminurica.

Around the yellow spot the hemorrhagic effusion presents a radiated appearance. At the periphery there are collections of pigment, forming small oval patches and irregular plaques along the course of the veins, some of them covering the veins.

Dec. 21st.—Two Heurteloups were applied.

Dec. 24th.—Upon examination the patient has, in the outer portion of the field, V = $\frac{1}{15}$, and reads Jäger No. 16 with some difficulty.

Jan. 2d, '71.—V = $\frac{1}{12}$, and Jäger 14 is read. He has quantitative perception of light in all parts of the visual field. When examined in ordinary daylight with the perimeter, a manifest contraction of the field is found in the upper and inner parts, with impaired perception in the lower.

With the ophthalmoscope the optic disk is seen pale and somewhat depressed, the veins are normally filled and the arteries are about three-fourths their normal size ; those which at first were interrupted near the margin of the papilla are now plainly seen no longer interrupted, but the large superior vessel above described remains unchanged. There are no evidences of retinal infiltration, but the macula and its surroundings are in the same conditions as on Dec. 16th. The pigmentary deposits along the veins are unaltered, and the hemorrhage to the inner side of the papilla is somewhat paler.

Jan. 3d.—The patient was discharged.

On the 14th of the following November he was seen for the last time ; he then had in his left eye V = $\frac{1}{15}$ and could read Jäger 16 as before. The field still presented the formerly described contraction. The ophthalmoscopic picture was about the same as when treatment was discontinued, except that the hemorrhagic effusions had been absorbed, and in their place pigment was deposited.

Case II.—J. K., aged 67, came to me Jan. 16th, 1873. His left eye was completely amaurotic and exhibited all the features of glaucoma absolutum. His right eye was the subject of chronic glaucoma. The intra-ocular pressure was increased, the pupil large, and the visual field contracted on the outer and upper sides, nearly as far as the point of fixation. His sight was $\frac{5}{30}$ and with + 10 he read Jäger 4.

The ensuing day I made a large iridectomy upwards ; the tension immediately diminished and became normal during the healing of the wound. After ten days he was discharged from treatment with V R $\frac{5}{20}$ and reading with glasses (+ 10) Jäger 2. The field of vision was less circumscribed. This improvement was continuous, as I had opportunities to observe him occasionally.

He was brought to my office on the morning of Oct. 21st, entirely blind, saying that the previous afternoon, while feeling perfectly well, he suddenly lost all sight in the right, his only good eye. Upon examination, I found stenosis and insufficiency of the valves of the heart with hypertro-

phy of the left ventricle, accompanying which was a highly-developed atheromatous condition of the arteries.

The intra-ocular tension was not increased and the refracting media were clear, but the papilla was hyperæmic and prominent, the veins dilated and tortuous, and the arteries thread-like, one upper and one lower branch being entirely obliterated. The peripherical branches and the arteries of second degree were not to be distinguished. There was retinal infiltration throughout the fundus—most marked in the vicinity of the macula lutea—producing a veiled appearance of the smaller vessels. Both to the inner and outer sides of the macula a large *extravasation* of blood was seen.

One leech was applied on the 21st and another on the 25th of October, and in the meantime subcutaneous injections of strychnia (gr. $\frac{1}{60}$) were used.

No improvement resulted from the treatment, but on the contrary the retinal infiltration increased, so that the vessels could scarcely be distinguished. Perception of light *nil.*

Under these conditions I gave up all hope of amelioration, and the patient was discharged as incurable.

III.—*A case of embolism of the lower branch of the art. cent. ret. in the right eye. The left eye being blind from embolic disease of long duration.*

Mr. H. S., 60 years of age, was brought to me in the forenoon of Dec. 7th, 1872, stating that upon awaking in the morning he had made the sad discovery that he was nearly sightless in his right eye, upon which he had been long dependent for all his useful vision. The whole visual field appears to him veiled and interrupted by dark spots (scotomata), which he sees sharply defined. Large objects appear only in their outlines, and are seen smaller and more indistinct in their upper halves. He must have become blind during sleep, as by his occupation, that of a tailor, he was employed up to a late hour the previous evening, and the sight of the other eye had been lost for two years.

Central fixation was absent, and, as I asked the patient to count my fingers held before him, he moved his eyes and head as if seeking a sensitive point in the retina, and in this way succeeded in counting fingers at about 4′, and in spelling Jäger 22.

The form, mobility, and intra-ocular pressure of the eye were normal. The pupil was regular in size and shape, but reacted sluggishly upon concentrated light.

Ophthalmoscopically the dioptric media were clear; the papilla was pale-

red in its upper half, and dull-white in its lower. The small lateral vessels of the disk were visible in the upper, but indiscernible in the lower half. The superior arteries and veins were normal in course and distribution. The inferior main branch showed no change before leaving the margin of the papilla, but at its first bifurcation its calibre suddenly increased and the vessel appeared somewhat more prominent than the papilla ; but from that point the two branches became pale and thread-like, and continued in their course as light-red (glistening) threads, the ramifications of which were lost in the cloudy retina. The accompanying veins were thick and partially tortuous.

The left eye was completely amaurotic, its papilla shining white and depressed, its small vessels were only noticeable as fine streaks. All the retinal arteries appeared very small, their branches obliterated, and were indicated simply as grayish lines. The veins were slightly larger than the arteries, yet smaller than the corresponding vessels of a normal eye, and upon some of them were irregular white patches. The retina was atrophic, and in the neighborhood of the macula were scattered a few pigmentary deposits. These changes were undoubtedly the results of an old embolism—which the patient's history also confirms—sight having been lost suddenly in the course of another disease and remaining unimproved by medication.

The man looks sickly ; his muscles are exceedingly weak ; he has suffered for years from rheumatism, and has been the subject of asthma with emphysema. His gait is shuffling and uncertain, but there are no symptoms of tabes dorsualis.

From his early history, obtained through the kindness of his family physician, it seems that some years since he suffered from endocarditis, which resulted in insufficiency of the mitral valve with compensatory hypertrophy of the right ventricle.

The treatment prescribed was rest, with the application of Heurteloups and a foot-bath containing aqua regia. It produced considerable improvement.

Dec. 11th.—Vision increased to $\frac{5}{40}$ and patient has central fixation. The general haziness of the visual field has disappeared, and the black spots are less dense. O. S. ; there is no change in the affected artery, but the retinal infiltration no longer exists.

Dec. 20th.—$V = \frac{5}{20}$, and patient is able to read single words of Jäg. 10. The visual field in the lower part is perfect, but in the upper half there is a peculiar sector-like defect, the apex of which nearly reaches the point of fixation.

Dec. 28th.—$V R = \frac{5}{20}$, single words of Jäg. 4 read with difficulty.

Jan. 3d, '73.—V R $\frac{5}{15}$, reads Jäg. 4 with ease.

The haziness and black spots no longer trouble the patient, and the fundus and visual field remain unchanged. He was discharged. Some time later I again examined him and found the picture of the fundus unaltered, and the same sector-like defect of the field with $V = \frac{5}{20}$ and Jäg. 4.

IV.—*Embolism of a branch of the art. cent. ret. with hemorrhagic infarction in the retina.*

H. H., æt. 25, presented himself to me March 1st, 1871. He states that after an exhausting travel on foot, two weeks ago, he noticed a dense black mist veiling the visual field of his left eye, which up to that date had possessed perfect sight; when he excluded the healthy right eye he had not been able to distinguish even the largest objects. His vision has somewhat improved, but he is still unable to work.

At no time had he ever experienced any pain in either eye, and his power of vision had always been equal in both. He has never suffered from any serious disease, and is in every respect a strong, hearty man, with a well-developed chest, and no abnormalities of the heart or blood-vessels.

Right eye emmetropic, $V = \frac{15}{15}$, Jäg. 1 at 3″. Fundus normal.

Left eye emmetropic, $V = \frac{15}{200}$, Jäg. 13 with difficulty. The refracting media are clear, and the intra-ocular pressure is normal. The visual field, measured at the distance of one foot, is totally deficient in the upper and inner quadrant, to a point reaching within about two inches of the line of fixation, the periphery of the upper outer quadrant is likewise impaired.

Opthal. examinat. in inverted image. The papilla is pale and bordered on its inner side by an atrophic crescent, its centre is excavated and whitish, but the vessels upon it and the lower part of the retina are normal. The superior arterial trunk, up to its bifurcation at a short distance from the edge of the papilla, is normal, as well as the resulting branch and its subdivisions which pass upwards; the other branch turns in a curved direction towards the inner and upper side, coursing above the mac. lut. From its point of bifurcation it appears like a small white thread, and can be traced throughout to the periphery of the retina, its divisions being distinguished as delicate white lines upon the red fundus. The superior veins are all markedly filled and tortuous.

An extensive extravasation of blood, commencing just at the upper inner margin of the papilla, extends over the mac. lut., and a large vein is seen to become lost in it. There are also multiple hemorrhages in the extreme upper portion of the retina, which appears somewhat hazy and infiltrated. The macula can be recognized as a dark-red disk.

March 2d.—Applied two Heurteloup leeches.

March 7th.—V L = $\frac{12}{20}$, Jäg. 4. Partial absorption of the large extravasation can be noticed.

March 8th.—Two Heurteloups again used.

March 14th.—V L = $\frac{12}{15}$, Jäg. 2. The free space between the extravasation and the papilla has increased. In the process of absorption the dark-red color has become paler, and the hemorrhage in contracting has assumed a more fusiform shape, the ends being thread-like.

March 17th.—Two leeches.

March 21st.—V = $\frac{12}{12}$, Jäg. 1. The defect in the upper inner quadrant of the visual field remains the same, but the diminished perception of light in the upper outer quadrant has disappeared. The absorption of the large hemorrhage has progressed, but there are no marked changes in the peripheric extravasations. The condition of the vessels is unaltered.

A NEW OPHTHALMOSCOPE, WITH A SINGLE DISK.

By H. KNAPP, M.D.

THE teaching of ophthalmoscopy led me to the construction of a simpler and cheaper instrument than that which I described in the last number of these Archives.

A series of auxiliary lenses, as used by Loring and others, appearing to suffice to the student and practitioner in ophthalmology, I had that series inserted into one disk, placed under a hole in the mirror, leaving the mechanism of fixation, rotation, and covering of the disk the same as in the compound instrument. The opening in the mirror is round, and has a diameter of 3.5 mm., and should, it seems to me, not be made smaller, because, on the one hand, it would increase the difficulties in determining the optical condition of the eye, on account of its diminishing the circles of dispersion, and, on the other hand, it would make the ophthalmoscopic image duller.

In order to ascertain the influence of the size of the hole in the mirror, I had a number of mirrors made, the holes of which varied from one to five millimetres. These mirrors I inserted into an ophthalmoscope which, in every other respect, resembled another one, the mirror of which had a hole of 3.75 mm. in diameter. In this way I could use the two mirrors in immediate succession and compare their effects. The result was that the best illumination was obtained by an opening in the mirror of 3.50 or 3.75 mm. in diameter. Reducing this diameter occasioned a proportionate diminution of the intensity of illumination, whereas, by increasing it, a dark cloud became conspicuous in the centre of the ophthalmoscopic field of vision. In this manner I thought to have arrived, as to the width of the hole in the mirror, at limits which, in the construction of ophthalmoscopes, ought not

to be transgressed in favor of some one or other peculiar arrangement.

The diminution of the hole in the mirror, furthermore, has the disadvantage of throwing a great quantity of light into the patient's eye, which dazzles him, and causes, by contraction of the pupil, a limitation of the ophthalmoscopic field of vision. A great portion of the rays returning from the eye under examination is intercepted by the zone of the mirror adjacent to the hole, and therefore lost to the observer, which fact accounts for the diminished brightness of the ophthalmoscopic image.

The arrangement of the new simplified ophthalmoscope is illustrated by the accompanying figure, which represents the instru-

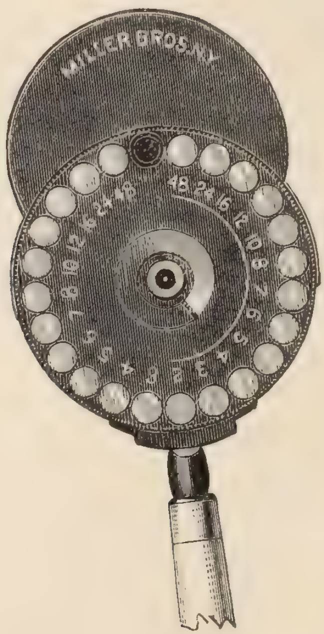

FIG. 1.

ment in its natural size. The disk contains an empty hole and twenty-three lenses, viz., + 3, 4, 5, 6, 7, 8, 10, 12, 16, 24, 48, and – 2, 3, etc., as the convex lenses. The refractive intervals

are as follows: from 2 to 3 $= \frac{1}{6}$; 3 to 4 $= \frac{1}{12}$; 4 to 5 $= \frac{1}{20}$; 5 to 6 $= \frac{1}{30}$; 6 to 7 $= \frac{1}{42}$; 7 to 8 $= \frac{1}{56}$; 8 to 10 $= \frac{1}{40}$; 10 to 12 $= \frac{1}{60}$; 12 to 16 $= \frac{1}{48}$; 16 to 24 $= \frac{1}{48}$; 24 to 48 $= \frac{1}{8}$.

The disk has a central spiral spring, held down by the cover, which is fastened by a thumb-screw and regulates the rotation of the disk. On the front surface of the disk is a point-like depression under each lens for the reception of the end of a spring, whenever the centre of an auxiliary lens is opposite the centre of the aperture in the mirror. The number of each glass can be read through an aperture in the cover when the glass is moved behind the hole in the mirror. The concave glasses are underlined; the convex glasses have no distinguishing mark. The disk can easily be rotated by the forefinger of the hand which holds the mirror, in such a way that the change of glasses can be effected without losing the ophthalmoscopic image, while the spring secures the accurate apposition of the centre of the lens to the centre of the hole in the mirror. The mechanism is simple and durable; the instrument itself is neatly wrought by Miller Bros., 1223 Broadway, New York. Its price is $20.

Although it has as extensive a series of auxiliary glasses as has hitherto been used in any ophthalmoscope for the determination of refraction—with the only exception of the double-disk ophthalmoscope which I described in the preceding number of these Archives—no other advantages have been sacrificed to this particular purpose. The instrument is inferior to none of those I know, as to convenience of use, durability of mechanism, protection of the glasses, absence of troublesome reflexes, purity and brilliancy of the ophthalmoscopic image, yet it seems to me that no other instrument possesses all these advantages thus combined.

In conclusion, I add a table indicating the elongation and shortening of the optical axis, corresponding to the different auxiliary lenses, if the mirror is held 20 mm. from the patient's eye. The table is a partial reproduction of that which I published in the preceding number. It is, of course, applicable to all ophthalmoscopes.

NUMBER OF GLASS.	OPTICAL AXIS.	
	SHORTENED.	ELONGATED.
2	6.12	5.08
3	3.95	3.49
4	2.91	2.65
5	2.31	2.14
6	1.91	1.80
7	1.63	1.55
8	1.42	1.36
10	1.13	1.09
12	0.94	0.91
16	0.70	0.69
24	0.47	0.46
48	0.23	0.23

The table shows that the intervals between the higher numbers are very large, and that this instrument, and those which have a similar series of glasses, do not suffice to make very nice gradations in the determination of refraction. The double-disk ophthalmoscope is the only one that admits of such determinations with sufficient accuracy. E. G. Loring, it is true, remarks, in describing a new modification of his ophthalmoscope (*Am. Jour. Med. Sciences*, January, 1874), that this disadvantage could be obviated by changing the distance of the mirror from the eye examined, an expedient which Mauthner * mentions, to prove that the introduction of small refractive intervals between the higher numbers of spectacles is superfluous. Determining with the ophthalmoscope in this manner the elongation and shortening of the optical axis, or the varying relief of the fundus oculi in cases of prominent exudations, ectasiæ, tumors, etc., would lead to continuous, troublesome, and hardly accurate measurements of the distance of the mirror from the eye under examination. For such cases, which, however, do not frequently occur, the double-disk mirror stands unrivalled, since its distance from the examined eye remains unchanged, its edge touching the orbital margin. If, however, we only want to recognize distinctly the details in the relief of the background of the eye, the instrument with a single disk fully answers the purpose—the intermediate numbers of the auxiliary lenses being replaced by changing the distance of the mirror or the accommodation of the observer.

* Lessons on the Optical Errors of the Eye. Vienna, 1872.

A CASE OF PARESIS OF ACCOMMODATION WITH APPARENT MYOPIA.

By A. SCHAPRINGER, M.D., of New York.

Mr. Morris R., æt. thirty-nine years, a merchant of New York, states that his eyes, especially the right one, soon are tired when he tries to read or write, and he complains at the same time of an unpleasant drawing sensation.

His right pupil appears larger than the left when a moderate amount of light falls upon the eyes; but on stronger illumination both pupils contract nearly alike.

The patient says that six weeks ago his right eye was struck by the cork of a champagne bottle, which apparently produced only a black-and-blue eye; the above-mentioned symptoms, however, have since made their appearance.

With his left eye he reads Jaeger No. 1 at 6″, with the right only at 8–10″ with a great effort, which he cannot sustain for any length of time. He says that he sees well at a distance; nevertheless he only recognizes Sn. XL. with either eye. *Convex* glasses do not improve his sight; but with *concave* No. 48 S. proves to be $= \frac{20}{20}$ in both eyes. The probability of mistake by inaccuracy on the side of the patient was excluded by his intelligence.

I ordered the use of a weak convex-glass for reading and writing, the application of the constant current to his eye, and on account of his supposed myopia, concave No. 48 for distance.

I saw him again a few days afterward. He told me that with his convex-glasses he could work with great ease, but the concave glasses seemed to be of no use to him, since he saw just as well at a distance without as with them. I proceeded again to test his visual power for distance, and was astonished to find that he could read Sn. XX. at 20′ without the aid of any glass.

In this case evidently the muscle of accommodation of the right side was partially paralyzed. The whole work of accommodation now devolving on the not paralyzed portion, this was placed under similar conditions as an intact muscle in a hyperopic eye, and the consequence was a permanent state of partial contraction. There was, at the same time, an associate spasm of the muscle of accommodation on the left side. This spasm disappeared by the use of convex-glasses, a similar result being so often met with in hyperopia.

KERATITIS VESICULOSA WITH SECONDARY GLAUCOMA.

By THOMAS R. POOLEY, M.D., of New York,

Assistant Surgeon N. Y. Ophthalmic and Aural Institute ; Ophthalmic Surgeon to Charity Hospital.

THIS form of keratitis has already been sufficiently well described by v. Graefe, Horner, and Schmidt, but the case which I am about to report has additional interest on account of the very unusual complication which followed. At the time when I saw it, I was not aware that any similar one had been published. I have, however, found two such observations recorded in literature. Inasmuch as these, so far as I know, are the only ones, I believe it will not be without interest to place them together with mine. The first case on record is by VON GRAEFE.* He says that limited corneal infiltration (genuine circumscribed keratitis) has hardly any influence on the tension, as estimated by the touch, and this may explain why it is rarely, if at all, the cause of glaucoma. He had only once seen glaucoma following circumscribed keratitis, and briefly reports the case on account of its rarity.

A woman, 50 years of age, who had suffered for many years from eruptions on the extremities, and occasionally on her left cheek, applied at the clinic, in June, 1866, for an ophthalmia of about one week's duration. We found an old eczema behind the left ear, and an eczematous patch about the size of a four-groschen piece at the lower part of the left cheek, on both sides blepharadenitis, and finally the special cause of her application, a circumscribed infiltration of the left cornea. The latter presented typical characters. There was an opaque and somewhat swollen spot, measuring 1.5 mm., opposite the lower edge of the pupil ; its centre was yellow and opaque, passed into a light gray towards the margin, and merged gradually into the healthy cornea ; the centre also projected and presented a slight excoriation. The pupil was small ; it dilated slowly on the use of atropine, owing to the existing irritation ; the vision was quite

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* Contributions to the Pathology and Treatment of Glaucoma, Archiv f. Ophth., xv., p. 108, and translation by Thos. Windsor, Royal London Ophth. Hosp. Reports, vol. vii., p. 65.

in proportion ; the tension was not tested at first, as there seemed no reason for suspicion. The disease was unusually obstinate, which was attributed to the eczematous diathesis. This led to a more careful examination, and it was expressly determined in the fourth, and again in the sixth week, that there was no complication with disease of the internal structures ; the tension was perfectly normal, not only within the physiological limits, it did not even reach the normal maximum, nor vary from that of the right eye. From this time, while the corneal disease remained perfectly stationary, there supervened a perfectly typical attack of subacute glaucoma. Paracentesis twice repeated had no permanent effect, and in the twelfth week from the commencement of the attack indistinctness of eccentrical vision on the nasal side necessitated iridectomy.

The operation was followed by the desired reduction of tension, and rapid disappearance of the obstinate corneal infiltration.

Graefe concludes that, as this is the only case in which he has noticed typical circumscribed corneal infiltration followed by glaucoma, it may well be imagined that the succession was accidental, or that both affections were due to the eczematous diathesis.

The second case was reported by Saemisch at a meeting of the Medical Section of the Society of the Lower Rhine, held in Bonn, March 21st, 1870.* He presented a patient who had suffered for five months from *keratitis vesiculosa*, and remarked that the case merited attention because it deviated from those put on record in two respects: *First.* Preceding the formation of the vesicle, there was an opacity of the cornea a few mm. long, arranged in long parallel or decussating stripes, formed in various layers of the cornea, similar to those described by Heyman, who supposes them to be opaque, or widened lymphatic corneal vessels. *Second.* When the disease was at its height, acute glaucoma supervened, for which iridectomy was performed with good result. Saemisch's conclusion is just the opposite to that of v. Graefe. He thinks that in this case we are entitled to suppose that glaucoma was not a casual complication, but that it was secondary to and induced by the corneal process.

I now come to my own case, which is as follows :

In August, 1873, a Jewess, of about 40 years of age, came to the Oph

* Berliner Klinische Wochenschrift, No. 37, p. 449. 1870.

thalmic and Aural Institute. Her left eye had begun to trouble her only a day or two before. She complained of lachrymation, photophobia, and supra-orbital neuralgia. There was considerable circum-corneal injection. On oblique illumination a small, perfectly transparent vesicle of the cornea, about 1‴ in diameter, below and a little to the outer side of the middle of the pupil, was to be seen. It was surrounded by a circlet of infiltration which gradually shaded off into the healthy cornea. The central vesicle was quite prominent, and at first I thought that I had to deal with an ulcer, with hernia of Descemet's membrane. Upon more careful examination, however, this was determined not to be the case, and the diagnosis of *Keratitis vesiculosa*, or *true herpes of the cornea*, was made. The pupil was of normal size, responded well to light, and dilated under atropine.

The anterior chamber of normal depth; T.n.; F. complete; S. = $\frac{20}{50}$. Ophthalmoscopic examination discovered no abnormality of the fundus.

The treatment employed was instillations of atropine, warm applications, and pressure bandage. Two days later I saw the patient again at her house. There was no material change in the appearance of the eye, but the pain was more severe. Leeches to the temple were ordered, and the other treatment continued. I saw the patient only twice after this, at intervals of a few days, and each time I examined the interior of the eye with the ophthalmoscope, as well as the tension, visual field and sight, and never found any indication of glaucoma. I then declined further attendance on account of the patient's obstinacy, but told her husband to take her to the clinic. This he did not do. I was, however, surprised to hear from Dr. Knapp that on Oct. 6th she presented herself at his office with absolute glaucoma. She was admitted to the Ophthalmic Institute, where I saw her again. The pupil was wide and immovable; anterior chamber very shallow; T. + 3; no perception of light, and illumination with the ophthalmoscope was impossible. The eye was still very painful. She had continued the use of atropine since I left her, but further than this had done nothing, although she had suffered severe pain all the while and sight was gradually abolished. A small opacity of the cornea marked the site of the vesicle. Dr. Knapp made a large peripheral iridectomy, merely with the view of relieving pain. The operation had the desired effect in reducing tension and relieving pain, but had no influence upon vision.

The other eye was in all respects normal.

These three observations are certainly sufficient proof to warrant the inference that there may have been a *causal* rather than a *casual* relation between the corneal and glaucomatous processes.

I am quite of the opinion that, in my case, the same conclusion must be arrived at as Saemisch came to in his, that is, that the glaucoma was the direct result of the corneal process. It is to be regretted that the opportunity of observing the course of the disease was wanting, and it cannot, therefore, be stated just when the glaucomatous process began.

In v. Graefe's case the symptoms of glaucoma set in about the twelfth week from the commencement of the attack, and in Saemisch's, when the disease of the cornea was at its acme, glaucoma supervened. It is difficult to state, in my case, whether the onset of the glaucoma was acute or not. I incline to the opinion, however, that it was sub-acute, as in v. Graefe's case.

As to the rôle which this form of keratitis may play in the ætiology of glaucoma, I have no theory of my own to offer, but I should like to call attention to the remarks made by *Max Schultze* (l. c.) in the discussion which followed the presentation of Saemisch's case.

He said that he had recently read a paper by SCHWEIGGER-SEIDEL, of Leipzig, *on the interstitial cavities* (Spalträume) of the cornea, and it seemed to him quite possible that the vesicles in question might be due to widening of these normal canals, which, according to the investigations of S.-S., show a great similarity to lymph capillaries. If the interstitial cavities of the cornea really communicate with lymph-vessels, the vesicles would have to be considered as ectasiæ of lymphatics. Schultze also referred to a paper by GUSTAVE SCHWALBE, on the lymphatic cavities of the eye, published in his *Archiv f. Mikroskopische Anatomie*, which contains a great many interesting observations concerning the communication of the anterior chamber, canalis Petiti, and the ciliary veins with lymph-vessels. These observations are apt to throw a new light upon the conditions which give rise to intra-ocular tension. In applying these observations to Saemisch's case, Schultze remarks that the fact of the vesicle of the cornea existing before the outbreak of the glaucoma, enhances the probability that the increase of intra-ocular tension might have been due to an impediment to the out-flow of lymph (perhaps to a valvular obstruction in the efferent lymph-vessels).

In conclusion, I would raise the question, whether in my case the long-continued use of atropine may not have had something to do with provoking the glaucomatous attack.

HISTORICAL NOTE CONCERNING THE PHYSIOLOGY OF THE COCHLEA.

By A. SCHAPRINGER, M.D., of New York.

EVERY aurist is familiar with the ingenious theory of HELMHOLTZ that there are fibres in the cochlea which correspond to every musical tone, and, by their vibrations, excite nervous fibres attached to them. It was first supposed by Helmholtz that the rods of Corti acted as resonators, but since the discoveries of HENSEN he has changed his opinion, and now thinks that the radial fibres of the membrana basilaris perform this function. According to this hypothesis, the shortest fibres, which are situated near the round window, would answer to the highest tones, and the remaining ones, which increase in length as we ascend to the cupola, would correspond to the lower tones.

It is an astonishing fact, that the same idea has been announced nearly two hundred years ago by DU VERNEY, at a time when the anatomy of the ear was still very incomplete, and the microscope had not yet been used for its investigation. Not being able to quote from the original French work, I copied the following lines from a Latin translation: *

"*Denique et lamina hæc* (sc. lamina spiralis ossea) *non tantum diversos omnes aëris tremores excipit, sed et structura ejus docet respondere eam posse diversis eorundem characteribus. Cum enim latior fit, ad initium primi gyri sui, quam ad finem ultimi, ubi in acuminatam desinit figuram, adeoque caeterae ejus partes ratione latitudinis paulatim diminuantur, dici potest, partes ejus latiores moveri posse immotis cæteris, adeoque tremere tantum lentius, quod gravibus tonis convenit: e contrario, cum partes ejusdem angustiores impelluntur, quorum tremores citiores sunt, atque ita tonis acutis respondent . . . ita tandem secundum diversos laminae spiralis motus, spiritus nervi, in substantiam ejus divisi, diversos recipiunt impressiones, quae cerebro varias tonorum figuras repræsentant.*"

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* Tractatus de Organo Auditus, continens structuram, usum et morbos omnium auris partium per Dn. Du Verney, è Gallico Latinè versus. Norimbergae, anno 1684.

This, in English, would read as follows :—

"This lamina (viz., the lamina spiralis ossea) by its peculiar construction, not only receives the vibrations, but evidently is impressed differently by high and low tones. As it is broader at the base, and gradually diminishes in width, we may suppose that the broader portion covibrates with the lower tones (the others remaining in a state of rest) and the narrower portion with the higher tones. By this means different nerve-fibres are excited, convey the impressions received to the brain, and thus produce sensations of tones."

The analogy of Du Verney's hypothesis to that of Helmholtz is evident, the only difference being that Du Verney supposes the covibrating apparatus to be a part of the bony labyrinth, while Helmholtz (and Hensen) place it in the membrana basilaris.

This hypothesis is mentioned in one of A. von Haller's works on physiology, but the name of its author is not given. My attention was called to Haller's work by my friend Mr. E. Zuckerkandl, in Vienna.

ANALYSIS OF A REMARKABLE CASE OF PHLEBITIS OF THE SINUSES OF THE DURA MATER, CAUSED BY OTITIS ; ENDING IN RECOVERY.

By R. WREDEN.

(Translated by D. F. Lincoln, M.D., of Boston.)

On the 28th of November, 1869, I was called to visit a boy, aged 15, son of the widow K——, who had been suddenly attacked by violent pains in his right ear. The following is the history of his case :

From earliest childhood the patient had been troubled by various scrofulous affections of the skin, and chronic catarrh of the nares and pharynx, and in the beginning of the year 1869 he had been treated by me as an out-patient for catarrh of the middle ear, affecting both sides. From May until the day before I saw him, he had remained in perfect health ; and the condition of his ears was as good as could be wished. But upon that day he was persuaded by some schoolmates to drink several glasses of pure brandy and rum, to which he was quite unaccustomed, and which made him very drunk indeed ; he was carried home in this condition, in very cold weather, losing his cap on the way, and was put to bed, but before the night was past he was suddenly waked from his drunken sleep by violent pains in his right ear, which grew worse as the day broke. Towards evening of that day his mother called upon me, in considerable anxiety, for she retained a vivid recollection of the death of her own husband, which took place some time in the previous winter, and was caused by an acute inflammation of the ear, lasting two weeks.

Present condition of patient.—Much excitement and fever. Pulse 120, and full. Body hot and moist. Face much puffed. Nose greatly swollen, especially at the tip. Nostrils very red, covered with pustules and crusts. Great swelling of the mucous membrane of the nose. Fauces very red, with much diffuse swelling. Tonsils only moderately swollen. No ulceration. No cough. Organs of chest and abdomen normal. Region of right ear greatly swollen, and very painful when touched. Skin not reddened. The tumescence is particularly marked behind the ear, over the mastoid process, upon which a lymphatic gland is to be seen, distinctly prominent in the midst of the swelling. The lymphatic glands are likewise greatly swollen, and very painful when

touched; those situated in front of the tragus less so. The concha is slightly tumefied, not reddened, but very painful. Diffuse swelling of external meatus, and much narrowing of the passage; much tenderness to the touch, but no redness. Membrana tympani only in part visible; is reddened, with diffuse swelling. The parts of the malleus not distinguishable. Cone of light absent. Hearing very poor. Watch heard only when applied to the concha or temple. Tuning-fork heard also when applied upon the swollen mastoid process; when placed on the middle of the vertex, the left mastoid process, or any other portion of the cranium, the sound is heard best in the affected (right) ear.

The patient says that the pains radiate from deep within the ear, shooting over the whole right half of his head and face, and into the teeth; sometimes even as far as the side of his neck, and the shoulder. The movement of chewing is painful. Swallowing is scarcely interfered with. The noise in his ear is accompanied by a violent pulsation. The patient has a continual feeling of giddiness, even when lying; when set upon his feet, he walks with a very tottering gait, and every step seems to send a wave of roaring noise through his head.

Eight leeches were applied behind the right ear, followed by a warm poultice and warm oil.—Gargle of infusum salviæ.—Ointment of oxide of zinc, for the nose.—A tablespoon was directed to be given every hour of the following mixture: ℞. Infusi laxativi viennensis ℥ iv, potionis Riveri ℥ ii, syrupi mannæ ʒ ss. Misce.

November 29.—After the leeches and poultices, the pains had greatly diminished, so that the patient was able to sleep during the night. Much less swelling of the face and about the ear; the latter is only slightly sensitive compared to the pain felt yesterday upon a slight touch. The motions of the head are easily performed. Meatus less swollen, not painful. Tympanic membrane still in a state of diffuse swelling, only the vessels of the malleus are injected. Tinnitus much diminished. Pulsation weak. Hearing better, = 8 inches. Giddiness is gone. Fever very slight. Pulse 86. Heat of body very little above the normal point. The patient asks for food and wishes to get up; the latter is refused and he is placed on strict diet. The medicine had acted but once upon the bowels, and that rather slightly; it was therefore ordered to be continued in double quantity every hour.

December 1.—The patient has risen, and, feeling perfectly well, has decided to drive to-day to the station with his mother, who is going to Moscow. This great imprudence has had no ill consequences as yet. The patient has neither headache nor earache; no fever; good appetite; cheerful frame of mind. Noise in the ears slight. Hears imperfectly,

but better than before (= 12 inches). Coryza still severe. Pustules and crusts still to be seen in the nostrils. Swelling and tenderness of the region behind the ear are gone; only the subauricular glands, and one lymphatic gland upon the mastoid process, are still slightly enlarged.

The next day (Dec. 2d) I did not visit the patient; but on the day after that I was again summoned.

December 3.—Twenty-four hours after my patient's drive to the station, he was attacked by repeated and severe rigors, with vomiting, headache, giddiness, tinnitus, and painful swelling of the entire right half of the neck. Very violent fever. Respiration slightly accelerated. Face puffy. Pulse 120, very full and hard; the body is glowing hot. Eyes normal. Great sensitiveness to pressure over the entire right side of the face and head. Headache on one side greatly increased by pressure. The ear itself is but slightly sensitive. The patient says he has no pain in the ear itself, but violent pains behind and below the ear, especially in the right side of the neck, which is enormously swollen from the mastoid process to the clavicle, though not reddened, and is very sensitive to pressure, especially in the course of the internal jugular vein. The external jugular is much dilated and swollen, and undulates with the respiration. The common carotid pulsates very strongly. The sterno-cleido-mastoid is very tense. The left side of the neck is neither swollen nor painful. Otoscopic examination with the same result as on the 29th ultimo, but the hearing distance has fallen to 11 inches. Slight catarrhal angina. No cough. Region of the abdomen sunken; muscles of the same very rigid. Liver and spleen enlarged and very painful when touched. The region of the stomach is sensitive; the ileo-cæcal region is not. Percussion and palpation of the large and small intestines, with normal results. Patient has vomited nine times (some mucus without bile), and has continual nausea. The tongue has a white coat, is of a bright red at the tip, scarcely dry. Great thirst. Entire loss of appetite. Ordered calomel, three doses in the day, of two grains each; friction of the swollen side of the neck with a mixture of mercurial ointment ℥ i and camphor ʒ i, to be applied three times a day; cold compresses to the head; "pills" of ice to be swallowed.

December 4.—Morning; condition the same as yesterday, but the patient has spent the entire night in sleepless delirium, has had three rigors, frequent vomiting, and two thin stools.

6 P. M.—Fever, unilateral headache, and vomiting not diminished. Tumescence of neck somewhat less prominent and painful. External jugular no longer visibly enlarged. Violent epistaxis has occurred four

times, which never happened to him before. At 5 o'clock epileptiform convulsions appeared, with a rigor.

The clonic spasms of the muscles of the upper and lower extremities and of the neck (jerking of the head to one side) lasted in all about five minutes, during which time the patient lost consciousness. Feeling of great heat and weakness upon awakening from the fit; intelligence perfect; questions are answered well and quickly. Great œdema of the right half of the face. The medicines prescribed continued.

December 5. Morning.—Delirium continued most of the past night. Towards morning the patient slept, but recollects that before he fell asleep a contracture of the flexors of the lower limbs occurred, so that with all his efforts he could not straighten his legs, which were flexed at the knees; this contracture was gone when he awoke. Fever somewhat less. Pulse 96. Swelling in the right side of neck much diminished, and less painful. Sterno-mastoid relaxed. But a very painful, very œdematous swelling has made its appearance on the left side of the neck since yesterday (phlegmasia alba dolens). Contracture of the left sterno-cleido-mastoid. The left external jugular vein is visibly dilated with enormous swelling. Previous to the development of this phlegmasia alba, last evening, a total loss of vision in the left eye occurred and lasted over an hour; those about the patient say that there was no apparent change in the aspect of the left eye, or any impairment of the voluntary movements of the latter. To day the sight of both eyes is equally good. Pupils react well. Upon the right cheek a circumscribed erysipelas bullosum has developed. The patient complains of pains in both sides of his head, and especially in the forehead; he speaks of noise in the ears and continual giddiness, but not of pain in the ears. The entire scalp, except the back part, is excessively sensitive to pressure, which, especially in the region of the left mastoid foramen, causes very violent pains. In the face there is no spot where pressure gives pain, except the patch of erysipelas. Vomiting is less frequent. Nausea continual. Tongue cleaner. During the night three rigors and four loose stools.—Medicines continued.

At 4 P. M., consultation with Prof. Eichwald.—On the right temple and the upper half of the forehead an erysipelas has appeared, which extends to the roots of the hair. Other points as in the forenoon. Careful examination of the organs of the abdomen demonstrates an enormous swelling of the spleen and liver, especially of the left lobe, so that the two organs nearly meet in the middle, while both are very tender when touched. Large and small intestines normal. In the lungs nothing unusual, although the patient complains of dyspnœa and stitches when he takes a deep breath. He has had two attacks of convulsive lateral move-

ments of the head (clonic spasms of the sterno-cleido-mastoid and trapezius). He says that he has less than the usual sensation in his legs, and that the right arm became anæsthetic for a time; in his legs, the application of tests proved the existence of partial regions of anæsthesia. Sight good. Hearing, right = 4″, left = 14″. The bones conduct the sound of a watch very poorly. Right side of neck less swollen than in the morning, and scarcely tender when pressed, except on the subauricular glands. On the left, the painfulness and swelling are still great.—℞. Quiniæ muriatis gr. xx, acidi muriatici diluti ʒ i, aquæ destillatæ ℥ vi. Misce. Capiat omnibus ij horis cochlearium (℥ ss) mensale.—Oleum camphoratum for the erysipelas.—Warm compress upon the bowels.

11½ P. M.—Fever less than during the day. Temperature in rectum, 40.1° C. Pulse 86. Respiration quiet. After the fatiguing examination of this afternoon, the patient fell into a delirium as soon as we left him, sweated a good deal, had another attack of rigor and lateral spasm of the neck-muscles, and vomited once. He took only one spoonful of the medicine, and said it gave him pain in swallowing. Slight diffuse swelling of the mucous membrane of the fauces, without plaques or other alteration; patient is said to have had a chancre recently. At our visit we found him sleeping on his right side, breathing quietly. Intelligence free. Pupils good. Sight and hearing as before to-day. Swelling of the left side of the neck less prominent and painful. Left external jugular vein no longer visibly swollen. Urine quite dense, not albuminous.

December 6, 3¼ P. M.—The patient continued in a slight delirium through the night, and did not fall asleep till towards morning. Since then has been decidedly better. Fever very trifling. Temperature in ano, 38.1°. Pulse 70. No rigors during the night. No vomiting. Some appetite has made its appearance; bouillon has been taken, and retained. Tongue cleaner. Two fluid stools. Thirst continues great. Very bitter taste in the mouth. Headache very slight; intelligence quite free; spirits very good. The scalp is not sensitive to pressure, excepting the soft parts covering the two mastoid processes, and the skin upon the forehead, upon which the erysipelas had gone on to the production of vesicles, and had spread nearly to the eyebrows, while the hairy part of the head was not attacked. The erysipelas has also spread over the whole of the right cheek. The regions of the mastoid foramina are still very painful. The swelling of both sides of the neck is almost gone, the tenderness wholly so. The sterno-cleido-mastoids are relaxed, and they have been free from clonic spasms since yesterday evening; in like manner, the contractures of the lower limbs have disappeared. Respiration quiet. Deep

inspiration causes little or no pain. Liver and spleen still sensitive to very strong pressure, but the region of the stomach is very much more tender than that. Hearing much better; right, 8″; left, 30″. Conduction through the bones, weak. Tuning-fork heard from the vertex more distinctly in the right ear. Right meatus is still somewhat swollen, and painful when the speculum is introduced. Tympanic membrane much swollen and diffusely reddened. No pus. Left meatus normal. Membrana tympani slightly opaque, without vascular injection. Handle of the malleus distinctly visible. Cone of light small and flat. Vision is normal. The nurse says he has several times seen the patient's right eye squint inwards. Medicines continued.

11½ P. M.—Consultation with Prof. Eichwald. Temperature in ano 37.70. Pulse 68. The patient has slept all day, in continual delirium. No stool and no vomiting since 3½ o'clock. Patient is low-spirited; for instance, he cried because he was not allowed to drink kwas. Liver and spleen enlarged, as yesterday. Upon the whole, the condition is the same as in the morning; the erysipelas has spread to the eyebrows, the fever has wholly disappeared.

December 7, 3¼ P. M.—Temperature normal, pulse 56. Patient is wholly free from fever and feels very well. The appetite is coming back (a bottle and a half of milk and a plate and a half of bouillon). Tongue cleaner. Two fluid stools. No vomiting or nausea. No giddiness. Head is still heavy. Left side of head, about the mastoid process, still somewhat sensitive to pressure. The erysipelas has not spread, but is much paler upon the forehead and right side of the face. The right eye is smaller than the left, in consequence of œdema of the lids, without redness. Epiphora and photophobia. Vision good. Left eye normal. Left half of face swollen and œdematous, without erysipelatous redness or vesiculation. Both pupils react normally. Hearing as yesterday. Noises in the ear slight. Neck no longer swollen, and entirely free from sensitiveness when pressed. No phenomena of nervous irritation.—Medicine continued.

December 8, 3½ o'clock.—Patient slept without once waking or talking in his sleep, or tossing about, from four o'clock yesterday afternoon to nine this morning. To-day I found him sleeping at 3½ o'clock. He feels stronger and more cheerful than yesterday; has a good appetite, and asks for cutlets. Tongue better. Normal stool. Left half of head no longer sensitive to pressure. Epigastrium less sensitive. Head feels only somewhat oppressed and heavy. No pains. The only complaint made by the patient refers to his right eye, which is very intolerant of light, weeps much, and cannot be opened by him on account of the immobility

of the upper lid (ptosis). The œdema of the eyelid is still very great. Upon examining the eyeball I found great œdema of the conjunctiva and exophthalmus.

The pupil reacts slowly, and is somewhat narrowed. Vision pretty good, but weaker than on the left side. Hearing worse ; right, 4″; left, 14″. Facial erysipelas paler than yesterday.—Suspend medicine, continuing only the camphorated oil.

December 9, 2½ P. M.—Patient feels better than yesterday, and wishes to get up. Appetite good, tongue clean and very red, stool normal. The right eye is to-day less œdematous and not intolerant of light, but the upper lid is still immovable. The left eye also begins to swell, especially its lower lid. Erysipelas gone ; desquamation is taking place upon the regions affected. Head still heavy.

December 10.—The œdema of the left eye has disappeared over night. The right eye is quite well. Patient may rise to-morrow.

December 12.—Patient is quite well, only the head does not yet feel quite fresh and free, especially when moved. The patient wishes to go out.

December 16.—Patient left his room three days ago, and can now be regarded as perfectly well.

REMARKS.—The case here described is of great interest, not only in regard to its symptoms, but also, and more especially, because it terminated in *cure*. On the one hand, we see developed in rapid succession the unmistakable symptoms of inflammatory thrombosis of the right transverse sinus, the superior longitudinal, and the left transverse sinuses, and finally the right cavernous sinus ; while on the other hand we see with astonishment an equally rapid disappearance of the threatening cerebral and pyæmic phenomena, which had involved the patient's life in such imminent danger. After a life-and-death struggle of two weeks the patient leaves his sick-bed, free from every trace of permanent injury in any single function ! This is a rarely favorable case of phlebitis of the cerebral sinuses, which is certainly deserving of a close analysis.

The origin of the inflammation of the cerebral sinuses is explained as follows : The patient was of a scrofulous diathesis, had previously suffered from inflammations of the ear, and was constitutionally predisposed to the occurrence of such disorders (as is shown by the recent death of the boy's father from a similar

affection). He caught a severe cold in the head in consequence of exposure to a cold winter's night with uncovered head; which gave rise to an acute inflammation of the right middle ear, that from its first appearance had the characteristics of an osteitis of the temporal bone, with special implication of the mastoid portion. Osteitis gave the conditions requisite for the development of osteo-phlebitis, which, for anatomical reasons, as is well known, very easily passes from the diploëtic bones of the skull, and the mastoid process, to the contiguous blood-vessels of the dura mater, involving phlebitis of the sinuses, with danger to the patient's life. But in our case the occurrence of phlebitis of the transverse sinus was favored by one particular circumstance, namely, the irritation and distension of the cerebral vessels caused by intoxication.

Under the combined action of the above predisposing and direct causes, an acute inflammation of the right middle ear commenced on the night of the 27th November. On the evening of the next day, this was complicated by symptoms referring to the transverse sinus. Among such symptoms must be reckoned, especially, the enormous œdematous swelling of the soft parts in, on, and about the ear, which had exactly the character of phlegmasia alba dolens. The subjective symptoms of constant dizziness, even in a lying posture, and tottering, which prevented his walking, must be here included; although the objection might be made, that the latter disturbance is explicable as a symptom of increased intra-auricular pressure, due to an affection of the labyrinth. But the persistence of the conductivity of the bones, the fact that the tuning-fork was heard better in the affected ear, without regard to the point of its application, and finally, the entire history of the case, contradict this assumption.

In consequence of the energetic measures which I took, the disease began to disappear rapidly. Even the hearing had risen, on the second day (29th), from +o * to 8″ for the watch. In four days the improvement was so great that the patient felt perfectly well, and on the fifth day (Dec. 1) was imprudent enough to accompany his mother to the railroad-station and

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* By +o I designate the fact that the watch *applied to the ear* is heard; by −o, that it is not heard.

thus exposed himself to taking a fresh cold. The penalty followed.

On the 2d of December, twenty-four hours after the second exposure, the inflammation of the cerebral sinuses returned with increased violence, with most threatening cerebral symptoms and very violent general symptoms, lasting five days, as follows :— Violent fever with frequently recurring rigors (three or four attacks by day, and as many by night), continual nausea with very frequent vomiting, violent headache, giddiness, tinnitus, great weakness, apathy, somnolence, delirium, general disturbances of sensibility and motility (hyperæsthesia and anæsthesia, clonic spasms, contractures and pareses of the head, neck and extremities, affecting chiefly the right side), epileptiform convulsions, disturbances of sight and hearing, etc. These manifold symptoms are all explained by the rapid spread of the inflammation of the sinuses, from the right transverse sinus to the others, whose successive implication could be distinctly traced from day to day, from point to point. The phlebitic process spread from the right transverse (*i.e.*, lateral) sinus :—

On the 3d of December, downwards to the right internal jugular vein.

On the 4th upwards to the superior longitudinal sinus ; and thence,

On the 5th, to the other side of the head, to the left transverse sinus and the left internal jugular vein.

On the 7th, to the base of the brain—the right cavernous sinus.

The general diagnosis of phlebitis of the sinuses of the dura mater will doubtless be admitted without question, but to many the differential diagnosis of the several affections of the sinus will appear rather a bold pretension. I think, however, that I can justify and establish it upon quite sufficient grounds. But, first, a few remarks upon the term "phlebitis." Why not "thrombosis," instead ? Against the supposition of a non-inflammatory thrombosis—as distinguished from the inflammatory form, phlebitis,—both the etiology and the symptomatology of our case speak decidedly.

For thrombosis owes its origin to mechanical influences, which retard the passage of the blood in the sinus, as—(*a*) a diminution of the propulsive force of the heart (marantic form) ; (*b*) in-

complete emptying of the right heart in consequence of impeded expansion of the lungs (form due to back-pressure); (*c*) narrowing of the lumen of the sinus in consequence of the pressure of tumors, foreign bodies, etc. (compression-thrombosis); (*d*) coagulations in a considerable region of afferent, or large efferent veins (by extension). It is not accompanied by fever, and produces no pyæmic symptoms.

Phlebitis, on the other hand, arises in the way of propagation (per contiguitatem) of inflammatory processes from the vicinity of sinuses to their own walls; or through direct traumatic injury of the latter; or by transference (per continuitatem) of the phlebitic process from single large veins that communicate with it. It is accompanied by violent fever, and very often gives rise to pyæmic or even septicæmic symptoms.

In the present instance we had, in closest contiguity with the right transverse sinus, an inflammatory process—otitis media acuta. It should be remarked of this, that it was conquered by the antiphlogistic treatment applied within the first twenty-four hours, before pus had formed in the inflamed tissues. Otorrhœa, and perforation of the membrane, were therefore not observed, and the hearing returned quite rapidly. In the attack of the 2d December, no new acute otitis occurred. The patient expressly said that he had no pain in his ear, but violent pain behind and below it. The outer ear was also but little sensitive to pressure, though the remainder of the right side of the head was very hyperæsthetic. But the hearing-distance had again fallen to 1″ for the watch, probably in consequence of enormous passive congestion and serous infiltration of the organ of hearing. This congestion, arising from the impermeability of the transverse sinus and the internal jugular vein, must of course have produced a greater impairment of function in the ailing ear than in the well one, and we find accordingly that the patient heard the watch at 14″ on the left (well) side, while the left sinus transversus and jugular vein were in a state of thrombosis; but on the right side, under similar conditions, he heard only at the distance of 1″.

The febrile phenomena were very marked, and lasted five days, from the 2d to the 6th December inclusive.

A specially characteristic feature of phlebitis is presented in the pyæmic rigors, which lasted four davs in succession, occurring

by day and night, in frequent attacks. Metastatic inflammation, *i.e.*, embolic infarction of the liver and spleen, was manifested by the enormous swelling of these organs, which lasted seven days. The sensitiveness of the epigastrium to pressure began to diminish two days after the fever had ceased, *i.e.*, on the 8th December. The suspicion of embolism in the region of the pulmonary artery was aroused in my mind by the patient's complaints of dyspnœa, and stitches during deep inspiration. Repeated careful percussion and auscultation, however, gave no information of disease in the lungs. But this negative result cannot be taken as a proof of the absence of embolic infarcta in the lungs, for it is known that these deep central infarcta may remain undiscovered by objective examination if they are covered by a considerable layer of aërated lung-tissue. Subjective phenomena also often fail us, for it is matter of experience that metastatic lobular pneumonia under some circumstances produces very little dyspnœa and cough, and no bloody sputa at all. Pus-formation in the pneumonic infiltrations was also probably prevented by the absence of septic infection in the thrombi, which gave origin to the emboli. If the original disease of the ear had been an old purulent catarrh of the middle ear complicated with caries, then the thrombi in the neighboring transverse sinuses would also have undergone a process of disintegration with development of pus and ichor, and such infected emboli might have given rise to fatal destruction of tissue in parenchymatous organs.

Let us now analyze the symptoms which have enabled us to trace the progression of the phlebitis, or the formation of thrombi, from the right transverse sinus in both directions.

The phlebitis of the internal jugular vein made itself known both on the right side (Dec. 3) and on the left (Dec. 5) by the following symptoms :

1. Enormous painful swelling of the corresponding side of the neck, without redness of the skin. As long as the thrombosis was confined to the transverse sinus, the œdema was confined to the skin of the region of the ear. But when the internal jugular was likewise plugged by thrombi, the phlegmasia alba dolens extended from the mastoid process downwards over the side of the neck to the clavicula. The points of greatest swelling and painfulness when touched corresponded with the course of the internal jugular

vein. The face was puffy, but was far from being so swollen as in cases of facial phlebitis. This is easily explained. If only one internal jugular vein is plugged, the blood arrested in the small twigs of the facial vein can still find a way to discharge itself through the numerous anastomoses by which it communicates with the external jugular of the same side or the internal jugular of the opposite side. The escape of the blood is retarded, but not wholly arrested. But in facial phlebitis this arrest takes place because the larger branches of the facial vein are plugged; therefore, enormous œdema of the tributary district of the skin is an unavoidable consequence. But if the phlebitic process extends also to the finer vascular ramifications, the swelling takes the erysipelatous character, with redness, heat, and here and there with elevations of the epidermis in the form of vesicles (erysipelas bullosum).* In our case we were able to follow from day to day the progress of the phlebitic process. On the 3d December, phlebitis of the internal jugular, with puffiness of the face. On the 4th, phlebitis of the large branches of the right facial vein, with great œdema of the right side of the face. On the 5th, capillary facial phlebitis in the veins of the right cheek, and circumscribed erysipelas bullosum upon the cheek. On the 6th, extension of the facial phlebitis to the smallest branches of the veins of the forehead, with erysipelas bullosum of that region. On the 7th, phlebitis of the right cavernous sinus, and characteristic symptoms of irritation and checked circulation in the right eye. On the same day, œdema appeared in the left side of the face, but did not assume the character of erysipelas. In general, the phlebitic symptoms were less developed on the left than on the right.

2. Remarkable dilatation of the external jugular vein, in which was distinctly visible an undulatory movement, an increase or diminution in fulness corresponding respectively to expiration and inspiration. This characteristic sign of thrombosis of the in-

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* The occurrence of facial erysipelas in facial phlebitis has been more fully treated of in my "contributions to the doctrine of thrombosis and phlebitis of the sinuses of the dura mater" (St. Petersburger Med. Zeitschrift, 1869, vol. xvii., pp. 61–137). In that paper the symptom of erysipelatous swelling of the face is spoken of as furnishing a valuable point in the differential diagnosis of phlebitis from thrombosis of the cavernous sinus.

ternal jugular vein was visible only one day; on the right side Dec. 3d, on the left, Dec. 5th. It is usually a temporary phenomenon, dependent on collateral blocking of circulation; for as the œdema of the skin increased, the prominence of the venous cord is lost, and its dark-blue color becomes undiscernible underneath the integuments and platysma.

3. Clonic and tonic spasms of the sterno-cleido-mastoid and the cucullaris. These are symptoms of irritation of the spinal-accessory nerve in the jugular foramen, due to thrombosis of the bulbus (sinus) of the jugular vein. The spastic contracture of the sterno-mastoids lasted on the right side two days, on the left one day (Dec. 3 and 4, Dec. 5). The clonic spasms produced a succession of convulsive lateral movements of the head, occurring in repeated brief attacks during the 4th and 5th.

The phlebitis of the superior longitudinal sinus was marked by two symptoms of importance in the differential diagnosis; repeated violent bleeding at the nose, and epileptiform convulsions, which both appeared on the same day (Dec. 4th).

The nose-bleed indicated an enormous back-pressure in the veins of the nasal cavity, due to plugging of the longitudinal sinus. By itself, this symptom has of course no decisive diagnostic import; but in connection with other symptoms, especially the simultaneous occurrence of epileptiform fits, it becomes very significant. The diagnostic signification of these convulsions, accompanied by loss of consciousness, in thrombosis of the longitudinal sinus, has been mentioned before in my "contributions to the doctrine of phlebitis and thrombosis of the dura mater," in which I have explained the facts by reference to capillary hemorrhages in the cortical substance of the convexity of both posterior cerebral lobes. These are due to the excessive choking of the blood-current from the surface of the brain, which inevitably follows plugging of the sagittal sinus, in both halves of the brain. These anatomical lesions of the gray substance of the convexity of the brain, which are naturally accompanied by great hyperæmia and hemorrhages in the membranes of the brain, produce somewhat the same symptoms of motor and psychical irritation which Griesinger* has noted as characteristic of cysticerci

* Griesinger: Wagner's Archiv d. Heilkunde, 1862, vol. iii., p. 240.

in the cortex of the cerebrum. A close analysis of the recorded cases of thrombosis of the superior longitudinal sinus has also taught me that all those individuals, affected with thrombosis of the upper sinus, who presented after death the above lesions of the gray substance, were subject to epileptiform attacks during their lifetime. Such attacks must therefore assume in our eyes a great importance, as points in the differential diagnosis of disease of the cerebral sinuses; and the matter is all the more important, as no author has hitherto recognized its existence.*

The phlebitis of the right cavernous sinus probably originated in this case from the facial phlebitis by continuation; the disease being transmitted along the superior ophthalmic vein to the right cavernous sinus. In favor of this view, we may cite the period of its commencement. Erysipelas bullosum appeared on the right cheek, December 5th; on the 6th, it appeared on the forehead also, and on the same day a squint of the right eye was observed. On the 7th, the phenomena of phlebitis of the right cavernous sinus were very clearly present. It is true that the disease might have been transferred from the transverse sinus to the superior petrosal sinus and sinus cavernosus; but this hypothesis is weakened by the consideration that the disease of the latter sinus commenced four days after that of the transverse sinus. Finally, the phlebitic process may have travelled to the cavernous sinus by both paths. That a great collateral impediment to the passage of blood through the cavernous sinus must arise when the transverse sinus of the same side is plugged, is evident; and such a transitory checking of the circulation may explain the loss of sight in the left eye, which occurred on the evening of the 5th of December, before the development of the phlegmasia dolens of the left side of the neck, and disappeared after a few hours.

The affection of the right sinus cavernosus was manifested by—1. Phenomena of irritation and paralysis of the abducens nerve, the first branch of the fifth, and the oculo-motorius; and 2. Phenomena indicative of blocking of the circulation in the eye.

The affection of the abducens, which runs close to the outer

* In the continuation of my paper, already referred to, I shall enter further into the discussion of these points.

wall of the cerebral carotid artery in the cavernous sinus, was indicated on the 6th December by internal strabismus of the right eye, *i.e.*, paresis of the external rectus.

The first branch of the trifacial, which lies close to the sinus below and outwards, gave token of the pressure to which it was subjected by unilateral headache, especially in the forehead and over the eyes (supraorbital nerve), epiphora (lachrymal nerve), and photophobia (reflex irritation, or hyperæsthesia of the optic nerve). These hyperæsthesiæ in the region of the first branch of the fifth pair were observed on the 7th December.

The oculo-motorius, which runs over the upper and outer wall of the sinus, presented on the 8th December a symptom of paralysis, *i.e.*, ptosis, with inability to open the eye.

The symptoms of ischæmia in the eye were strongly marked and lasted three days (Dec. 7, 8, 9). They consisted in œdematous swelling of the eyelids, of the conjunctiva of the eyeball and the retro-bulbar connective tissue (exophthalmus). The power of vision was also weakened, probably in consequence of intraocular venous congestion (mechanical hyperæmia of the retina), for, when the external manifestations of congestion of the eye had disappeared, the power of vision became normal again.

In conclusion, it may be added that the patient has enjoyed complete health up to the present time. Neither functional disturbances of the organs of sense and the brain, nor any other ill consequences whatever, have seemed to follow this severe illness.

NEW INVESTIGATIONS ON THE METHODS OF EXAMINATION AND THE DERANGEMENTS OF HEARING.

By Dr. OSCAR WOLF, of Frankfort-on-the-Main.

(Translated by Drs. C. J. Blake and D. F. Lincoln.)

In the following work I have endeavored, on the one hand, to define more exactly than was possible in my book, which appeared three years since,* the physical-acoustic character of the sounds of the human voice, and therewith to satisfy the objections made by some of my critics, which were principally to the effect that the work was not a finished one, and could not be considered as complete; on the other hand, I extended the domain of research, which I had confined in my book to visible defects, namely, to those of the sound-conducting apparatus, to include those which are invisible. I refer to defects of the sound-perceiving apparatus, the auditory nerve.

I hope, therefore, through observations extending over a period of several years and the careful study of a pretty extensive material, to have contributed a few stones to the firmer clinical structure of the diseases of the labyrinth.

Possibly my colleagues, like myself, have attained the conviction that the human voice is the most perfect conceivable measure of hearing, and it follows as a matter of course that all attempts at mechanical contrivances and artificial apparatus for testing the hearing distance have been and probably will be of no effect, because it is not readily supposable that any artificial apparatus which may be constructed can so express the delicate shades in pitch, intensity and timbre as does that natural instrument, the human speech, in so varied a degree. Although the speech, on account of the great number of tones, and the most varied pitch, intensity and timbre, cannot be made available with as much mathematical accuracy as the test types for determining the distance of vision or the chemical reagent for analysis, never-

* Sprache und Ohr. Acustisch-physiologische und Pathologische Studien. 1871. Braunschweig, Vieweg & Sohn.

theless it is still a reagent, and moreover an exceedingly delicate and sensitive one. We question with each sound which passes from the human lips, and the nervous apparatus of hearing answers us with such astounding accuracy, but I might also say "unfortunately" in so complicated a fashion that we must first study the answer long and carefully in order to understand it rightly and explain it according to physical laws. But we shall then be able, with careful attention on the part of both physician and patient, and by means of the delicate reaction of the tones of the voice, to determine accurately the majority of the anomalies of perception.

Before we can employ speech as the basis of such a physical examination of the functions of the ear, the speech itself must first be physically examined, and its various sounds apportioned into their definitely determined scale and into their various tone elements according to pitch, intensity and timbre.

Knowing the above three characteristics of a vocal sound, there is also to be considered the force of the excitation by which one or the other of the corresponding fibres in the labyrinth is set in vibration.

The examining physician, who has already in mind each of the three characteristics of the vocal sound, with each word or each simple sound which he employs in testing the hearing, will therefore be able to come to a conclusion, from the way and manner in which the patient describes his perception of the tone, as to the pathological condition of the different portions of the ear tested, either the sound-conducting or sound-perceiving apparatus.

Criticism of the Methods of Testing the Hearing Heretofore Employed.

In the knowledge that the perception of the voice afforded one of the most important points in the critical examination of the majority of diseases of the ear, the voice was formerly placed in the first rank as a means of test—but only quantitatively, that is to say, at various distances one word or a sentence was spoken, which the patient was either required to repeat or at least to say whether he had understood or not; three grades of intensity were employed, loud, medium or conversation tone and whisper-

ing. In this manner it could of course only be determined at how great a distance certain casually selected words could be understood. Concerning the quality of the perception, that is, how and what single tones the patient heard and what he did not hear or heard only indistinctly, why he understood one word and did not understand another spoken at the same distance—for this critical examination there was wanting that knowledge of the acoustic character of the individual tones of speech which have been detailed. In the following pages I hope to exhibit anew the great service of such knowledge for diagnosis, prognosis and treatment of diseases of the ear, and shall consider myself fortunate if my results stimulate controlling experiments. I will first, however, present a short critical review of the remaining methods and means which have heretofore been employed for the purpose of testing the hearing.

Test of the Hearing by Means of the Ticking of the Watch.

Concerning the value of this method of test almost all authorities are united, and the same faults and deficiencies mentioned by V. Tröltsch in 1862, and Gottstein in 1868, are found repeated in the text-book of Gruber published in 1870; that is to say, there is shown in the direction of tests for hearing no improvement corresponding to the advances in otology. The reason lies in the fact that with the ticking of the watch we test the patient with but two tones out of the whole scale, and those neither very pure nor precise. The hammer or anchor strikes upon the cogwheel, and by its impact calls forth two weak tones which are somewhat intensified by the resonance of the case. The pitch of these tones is not easily determinable; the intensity is measured by the observer according to the average distance at which persons of normal hearing are able to perceive the tick. The deficiencies imputed by other authorities are all explainable, on considering that at the conclusion of the tests with the watch we have determined nothing more than the reaction of the affected ear to two relatively weak and impure tones. Should it happen that the patient has a disturbance of the nerve-fibres corresponding to these two tones, it is conceivable that, while absolutely deaf to the ticking of the watch, he may hear other far weaker tones which hold a different position in the scale, and on

the other hand, that the patient may hear the ticking of the watch at a relatively greater distance, and at the same time misunderstand certain spoken words and even loudly spoken tones.

This latter anomaly of perception is particularly noticeable in entire destruction of the membrana tympani, malleus and incus, as I have before determined. These defects, however, afford no ground for the abandonment of the test with the watch, as it is a not unimportant link in the chain of diagnostic expedients, which is made up among others of the watch, tuning-fork, voice, objective examination, and the air douche.

On the other hand, the test with the watch is possessed of material advantages.

From early youth the watch is a favorite, trusty companion ; by listening to its tones, the attention of the infant is awakened, the most boisterous, as well as the most timid child is pleased with the first tests of its hearing by means of the watch, and usually remains quietly attentive. The adult, by the diminution of the distance at which he formerly heard his watch, is often first aware of the commencement of an affection of the ear, and thereby induced to consult a physician. This means of testing the hearing affords a tone of absolutely constant intensity, readily available and comprehended by all. There are, nevertheless, certain precautions necessary to avoid material deceptions. With the majority of patients, it is well to follow the test with the eyes open by a test with the eyes closed for purpose of comparison, as many persons will give false answers, either frivolously or from self-deception, or from fear of the subsequent use of the air douche, or Politzer's inflation. Having determined the hearing distance of the patient, the physician enters in his journal, under the heading, "watch," the following simple remark : "Slightly in continuo," or abbreviated, "slightly i. cont.," that is, the patient hears the ticking of the watch slightly when in contact with the auricle ; or "in cont.," that is, he hears it plainly, both tones of the watch distinctly on contact with the ear, or 1″, 2″, 3″, etc., that is, he hears the watch 1, 2, or 3 inches from the ear.* The test for the concep-

* I prefer, in testing the hearing, the notation of inches and feet, according to the decimal notation of the metre system. A span of my hand between thumb and middle finger, including the two last phalanges, gives exactly a Prussian foot. One stride is

tion of sound, conveyed through the bones of the head by means of pressing the watch upon the temple or processus mastoideus, seldom gave any important diagnostic points. It is well known that with the increase in density and friability of the bony tissue, which is observable from the fiftieth year upwards, the conduction of sound is decreased.

Hence we find frequently that persons of that age, showing no sign of disease of the ear, cannot hear the ticking of the watch from the temple or processus mastoideus ; while, on the other hand, younger persons, suffering from affections of the sound-conducting apparatus, hear the watch more distinctly through the bones of the head than through the meatus.

This department of the test of hearing enlarges in its proper fashion the tone picture, in that it affords some conclusions as to the sound conductibility of the bones of the head, and should, therefore, be employed on each introductory examination of a patient.

Tests by Means of the Tuning-fork.

Treatises upon the diagnostic and prognostic value of the tones of the tuning-fork have been published by E. Mach,* Erhardt,† Politzer,‡ Lucae,§ Moos,‖ and Magnus.¶ No new discoveries of importance in this connection, however, have appeared since the late work of Politzer in 1871.**

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exactly 2½ Prussian feet. When I retreat from the patient in the subsequent test with the voice, I count the strides, and so obtain a ready and exact result in feet.

* E. Mach. "Zur Theorie des Gehörorgans," Sitzungsberichte der Acadamie der Wissenschaften. Wien, B. 48. 1863.

† Erhardt. Clinische Otiatrie. 1863.

‡ Politzer. "Untersuchungen über Schallleitung im Gehörorgan im gesunden und kranken Zustande." Archiv f. Ohrenheilkunde, B. 1, H. 1 u. 4 ; also, "Neue Untersuchungen über die Anwendung von Stimmgabeln zu diagnostischen Zwecken bei Krankheiten des Gehörorgans." Wiener Med. Wochenschrift. 1866.

§ Lucae. "Untersuchung über die s. g. Kopfknochenleitung und deren Verhältniss zur Schallfortpflanzung durch die Luft." Archiv f. Ohrenheilkunde, H. 4, and "Weitere Untersuchungen über die s. g. Kopfknochenleitung und deren Bedeutung für die Diagnostik der Ohrenkrankheiten." Archiv f. O., B. 5, H. 1 u. 2 ; also, "Verwerthung der Schallleitung durch die Kopfknochen." Berliner Klin. Wochenschrift, 1871, No. 10.

‖ Moos. Handbuch d. Ohrenheilkunde. S. 37 et seq.

¶ Magnus. "Ein Fall von partieller Lähmung des Cortischen Organs." Archiv f. O., B. 2, H. 4.

** Politzer. "Beiträge zu den Hörprüfungen mittelst der Stimmgabel." Wiener Medicin. Presse. 1871.

By means of the vibrating tuning-fork we present to the ear a tone comparatively pure and having almost no prominent over-tones. If we place the butt of the fork upon the head it causes an intense excitation of the organ of hearing, which is so powerful with some tuning-forks that, even in cases of extensive changes in the sound-perceptive structures, as in deaf-mutes, the tone is not only heard, but may be imitated by the voice.

From these facts the advantages and disadvantages of this method of testing may be easily inferred. We present to the patient a clear and relatively pure, but also, in its effect upon the auditory nerve, relatively powerful tone, one which is often heard through the bones of the head in cases where other tones, perhaps of the same pitch, but weaker, and compound tones, such as are given by the consonants in speech, are hardly perceptible. I recall several cases of deaf-mutism in which the tone of my large bar tuning-fork, C°, was heard through the bones of the head.

Deaf-mute children desired the repetition of the experiment with this fork, because, in the rare pleasure of hearing a musical tone, they experienced a new and pleasurable sensation.

Experts have employed tuning-forks with rectangular and also with round arms of different lengths and diameters, and affording different tones.

The tuning-forks lately made by Dr. König, of Paris, have also been largely used. They are fitted with movable clamps, which serve the purpose of giving various tones with the same tuning-fork.

The tuning-forks render good service in the majority of cases in which we have to deal, not only with delicate and differential tests of the function of the sound-perceptive structures, but still more in the determination of the vibratory and resonant conditions of the sound-conducting structures. I employ especially the bar-shaped C° tuning-fork* and the square fork giving a tone of A^1 (Paris a), which I use in almost every introductory examination of an ear patient.

The bar-shaped fork A° has the advantage that its tone is not heard through the air at the distance of even a few inches; the patient cannot deceive himself as to the hearing of either ear,

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* Compare Politzer's "Neue Untersuchungen," etc. Wien. Med. Wochenschrift, 1866.

since he can hear the tone of the fork only in the ear near which it is held. When, for example, I close the right ear completely, and hold the vibrating tuning-fork near that side of the head, I cannot hear the tone, although the left ear is free, because the sound does not reach that side of the head.

The explanation of the increased perception of the tone of a tuning-fork, placed upon the head, in the ear in which the sound-conducting structures are diseased or diminished in their vibratory power, as also the physiological and pathological importance of this phenomenon, is given in the treatises above cited, and also in the case published by myself.* On striking the C° tuning-fork forcibly on a hard substance there often occur, as the result of longitudinal vibrations, very high over-tones.

The observation of Politzer and other experts, according to which certain patients heard only these high over-tones ("hohes Klingen"), and not the deep dominant of the fork ("das Brummen") through the ear, is explainable, in my opinion, by the fact that in a certain class of diseases of the ear certain single tones of the scale are less readily perceived, while the remainder are easily heard. In patients possessed of a musical ear there is sometimes detected, by means of the tests with the tuning-fork, a dissonance in the affected ear. This evidences itself generally in a sharping of the tone of the fork, resulting from the increased tension of the diseased structures.

The disadvantage of this method of testing the hearing, or rather its incompleteness as a test, is plain when we consider that we subject the patient only to a single, and at the same time very intense musical tone, concerning the value of which unmusical patients cannot always give correct estimates. For delicate tests the fork has too great intensity of tone. The use of several tuning-forks requires too much time and is not always remunerative, as many patients, while hearing the tones of the forks very clearly, hear the much weaker tones of consonants very poorly. For some time past, too ardent hopes have been based upon the expected discoveries to be made by means of the tuning-fork, and these, after a lapse of several years, with no important ad-

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* Unterbindung der Arteria Carotis, etc. Compare this archive, Vol. 2, No. 2, p. 52, *et seq.*

vances either for diagnosis, prognosis, or treatment, have been somewhat disappointed; nevertheless, I would not omit the tuning-fork in any examination; it has proved itself a firm link in the chain of our means for testing the hearing.

I shall take occasion further on to speak of experiments with other acoustic apparatus and musical instruments, which have been employed especially for detecting defects of the sound-perceiving structures.

Tests by Means of the Human Voice.

The determination of the hearing distance, as well as of the limit of hearing or quality of the sensation of an affected ear, must be made as rapidly as possible in order not to consume too much of the time and patience of both patient and physician; it must also be exact, that is, it must include as nearly as possible the range of tones occurring in the usual communications of mankind; above all, however,—and therein lay from the beginning the basis of the endeavor at obtaining an invariable test,—it must be of equal value in all repetitions of the examination, and equally comprehensible by all patients.*

If, by means of the watch and tuning-fork, we can sketch in a few lines of the tone-picture which we wish to create, the tests by means of the voice give the picture form, expression and character.

When we consider that our aid is sought by patients of various ages, and of every variety of intellectual and bodily development, from the delicate infant, whose tone-life has but just awakened to a few tones and words, to the old man, nourished and refreshed with the best of that living speech which flows from the fountain

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* On account of their completeness I mention two among the attempts towards obtaining a measure of hearing. Dr. v. Conta in Weimar (Arch. f. O., Vol. i., No. 1, p. 107, *et seq.*) would determine the perceptive power according to the period during which a vibrating tuning-fork was heard. He advised that such an instrument should be held opposite one end of a conversation tube, the other end of which was placed in the ear to be tested. This so-called measure of hearing has naturally never been practically availed of. Prof. Lucae, of Berlin, published within a year since an account of an apparatus (Archiv f. O., Vol. 6, No. 4, p. 276), "Maximalphonometer," which should serve the purpose of determining more accurately the intensity of the voice, that is, the expiratory pressure employed in speaking. I can hardly, however, confirm the practical results of the use of this instrument in testing the hearing of an affected ear.

of life; from the simple peasant, whose power of hearing has rarely been developed to the understanding of music, to the composer, in whose imagination its harmonies are so clearly and firmly sketched that they stand before him almost as embodied things, it is clearly necessary that the test by means of speech should be reduced to a system, by means of which we can define, with all variety of subjects whose hearing is affected, as to what they do or do not hear.

Method of Testing the Perception of Speech. Selection and Rhythmical Value of the Vocal Sounds.

Having concluded the questions relating to the history of the case, name, age, condition, and residence of the patient, duration and character of the disease, any former affections and the previous treatment, as to the existence of pain, otorrhœa, tinnitus aurium, etc., and having concluded the test by means of the watch and tuning-fork, I cause the patient to close first the left ear tightly with the finger or with a rubber stopper, the right ear, which is to be tested, being turned towards me, and the eyes averted that the motion of the lips may not be seen, and then test the perception of speech in general, by pronouncing at various distances syllables, words or sentences, and obliging the patient to repeat them. For this purpose I employ three grades of speech, or intensities of tone: the loud tone, the medium or conversation tone, and, mostly, the whisper.* According to the manner in which the affected ear reacts to the test-tone employed, records are made in the journal, under the heading "speech," first the more common signatures, l., m., w., that is, loud, medium, or whispering tone, in connection with a record of the distance of the speaker from the ear tested, measured in feet.†

The record 4′l., 4′m., 4′w. would indicate that the patient heard a loud, medium, or whisper tone at a distance of 4′, while the record 4′l. in con., 4′m. in con., 4′w. in con. would indicate that

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* Concerning the acoustic differences of the three grades of speech, compare what follows, and also p. 54.

† Similar records were adopted by Dr. Wendt, of Leipzig. Compare Wendt, Communications concerning the cases observed in my policlinic. Archiv f. O., Vol. 3, No. 1, p. 27.

the patient heard a sentence connectedly spoken within a distance of 4′. When the test proves that the patient does not understand

Journal No. Date.		Name.		Age.		Occupation.	Residence.		Diagnosis.
		Duration.	Development	Prob. cause.	Pain.	Otorrhœa.	Tinnitus.	Hered. tendency.	
History.	Right.								
	Left.								
		Meatus	Mem. Tymp.	Tuba.	Hearing Dist.		Conduction thro' Bone.	Tuning Fork.	Pharynx.
Present Condition	Right.				Watch			M.	
					Speech			V.	Nose.
	Left.				Watch			M.	
					Speech			V.	
Progress.									
Therap.									
Notes.									

certain words, I require him to repeat what he supposes he has heard, and it is generally found that the patient has heard the

vowel sounds of the word correctly, but certain of the consonant sounds either incorrectly or not at all; there exists, therefore, a confused or perverted perception of consonant sounds. I note, therefore, recurring to the example above given, 4′l., or 4′m., or 4′w., with c. p. (consonant permutation), that is, at a distance of 4′ the patient begins to hear the consonant sounds of a word in loud, medium, or whispering tone, incorrectly.

I then proceed to the examination of the membrana tympani and use of the air douche, and note the results of auscultation, and also the changes in appearance of the membrane after inflation, and again test by means of the watch and voice. Should I find persisting anomalies, especially in the perception of the consonant sounds, I then proceed to the qualitative tests for the vocal sounds, and endeavor to determine the limits of perception of each independent (selbsttönend) tone. From all these facts I construct the diagnosis and the tone picture of the patient, and compare this with the tone picture of the normal ear.*

As I have previously signified, the consonants give the most difficulty to an ear that is badly diseased, while the vowels are often able to stimulate to activity the apparatus for perceiving sounds, even when its functions are seriously impaired. This is explained by the fact that vowel-sounds, produced by the very complete mechanism (Zungenwerk) of the larynx, have a rich, full timbre; their sound-waves are very regular, and possess, individually, a much greater amplitude (Wellenbreite) than those produced by consonants, which are mostly formed by the less accurately adjusted organs of the mouth, either by the stroke of the tongue or lips, or by the friction of the current of expired air.

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* I have arranged my journal according to the principles of this method of examination, which has proved of value to me for several years. I add here the plan for a page of a journal, the use of which may afford some one or other among experts convenience for ready and comprehensive exhibition of the results of an examination. Under the heading "speech" the general hearing distance only would be recorded, for example, the record, 4′l. with c. p.; the results of the qualitative tests for single vocal sounds would then be entered in the broad marginal space which is reserved for all important remarks. I consider it advisable, as do others, to enter the name of the family physician. The capitals M. and V., under tuning-fork, signify Meatus aud. ext. and Vertex, that is, whether the tone of the tuning-fork was heard through the meatus or from the vertex, through the bones of the head.

In my previously mentioned studies* I have given a new classification of the consonants—based upon acoustic and physical laws—according to which they are either self-sounding (selbsttönende) or sound-borrowing (tonborgende). The former class embraces those sounds which are formed by the apparatus of the oral cavity with a sound which is independently audible, and which can be defined in relation to its pitch, intensity, and timbre ; such sounds are R, B [not equivalent to the English B : Translator], K, T, F, S, Sch, and G molle.† The second class comprises those which attach themselves to a vowel-sound, and are obliged to borrow from it some sound, in order to be distinguished by the ear ; musically speaking, they may be designated as the appoggiatura and note of complement to a vowel-sound ; ‡ such consonants are H,§ L, M, N, W.

At the time I made this division I was led solely by considerations relating to tests of the hearing distance of the diseased ear, and nothing was further from my thought than to add to the many existing classifications of sounds a new one, adequate to meet the requirements of linguistic science.‖

I insert here a table of the pitch and relative intensity of the vowels, and of such consonants as are important in testing the

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* Cf. Sprache und Ohr, s. 15 ff.

† G as in *selig;* not an English sound.—TRANSLATOR.

‡ It would be more correct to say, "Sound-borrowing consonants are those which cannot be given without the assistance of the vibrations of the vocal chords." They are accompanied in their pronunciation not by a full vowel-sound, but only by a humming sound, which is the expression of vibrations of the vocal chords delivering incomplete and inexact sounds. Therefore, the sounds M and N are justly termed semi-vowels, or half-vowels.

§ The H-sound certainly acquires a very weak proper tone, as the expression of the friction of the forcible rush of air against the parts of the mouth ; the pitch of this tone cannot be determined.

‖ Although I clearly stated these principles upon publishing the work already mentioned, yet they have been declared unintelligible by a critic, Herr Merkel, of Leipzig (Schmidt's Jahrbücher, vol. cl., Heft 4. Neue Zeitschr. f. Musik, Jahrg. 1871, Nos. 30, 31, 32. Litterarisches Centralblatt, 1871, No. 36). My colleagues will (I hope) be convinced by what is to follow in this article, that in making practical tests of the hearing the most important thing to do was—to separate the sounds called by me "selbsttönend," which can be defined in the character of their tone, and may be *isolated* for the purpose of testing, from those called "tonborgend," which taken by themselves are insusceptible of an acoustic definition, and cannot be discriminated by the ear without the addition of a vowel sound.

hearing. In establishing a scale of this kind we cannot, of course, assign an absolute value in numbers to the strength of tones, but can only speak of the strength of spoken sounds as compared with each other. The results here given were obtained in experiments made by George Appunn and myself. We posted ourselves in a garden-walk, on a still day, in the afternoon, and while one of us uttered the different sounds as loud as possible, each separately, the other one noted the distance within which he was able clearly to distinguish the spoken sound from other sounds. I shall subsequently show that experiments (made after the publication of my work above mentioned) conducted in a closed hall gave essentially the same relation between the spoken sounds, as regards loudness. My statements in regard to pitch have been confirmed by other observers,* and my own repetitions of the same experiments have always given the following result :—

Spoken Sound.	Pitch of the Ground-tone.	Relative Intensity. The sound was distinguished at the distance of
A	b^{ii}	360 paces.
O	b^{i}	350 "
Ei and Ai	——	340 "
E	b^{iii}	330 "
I	d^{iv}	300 "
Eu	——	290 "
Au	——	285 "
U	f^{0}	280 "
Sch	$f^{iv} + d^{iv} + a^{iii}$	200 "
S	$c^{iv} - c^{v}$	175 "
G molle and Ch soft	d^{iv}	130 "
Ch rough and R uvulare	——	90 "
F (F and German V)	$a^{ii} - a^{iii}$	67 "
K (K hard and German G)	$d^{ii} - d^{iii}$	63 "
T (T and German D)	$f^{ii} - f^{iii}$	63 "
R linguale (without vocal sound)	$\left\{ \begin{matrix} C^{-3} + C^{-2} \\ C^{-1} + C^{0} \end{matrix} \right\}$	41 "
B (German B and P)	e^{i}	18 "
H (as augmented breathing)	——	12 "

* Among others, Prof. Lucae : Berl. Med. Wochenschr., 1872.

The limits of human speech are here seen to be more or less under mathematical laws ; they reach from R lingual, the deepest sound, with 16 vibrations in the second, up to the S sound with 4032 vibrations. In musical language, its deepest tone begins with the sub-bass C or C^{-3}, and its highest ends with about c^{v} ; it therefore embraces 8 octaves. Within these limits the vowels and consonants present the greatest variety of intensity and timbre, from A, the strongest and richest sound, to H, the poorest and weakest.

On the Acoustic Laws of Speech in Enclosed Spaces.

In my paper I gave a statement of the proportionate strength of different sounds, deduced from experiments made by us in the open air ; now it seemed desirable, both for the object of testing the power of hearing, and also for the purposes of musical instruction and rhetoric, to investigate the power of the sounds uttered in speech, by experiments made in enclosed spaces. For this purpose I made use of a great concert-hall, which is celebrated for its good acoustic properties. The greatest distance from the last chair on the platform to the last seat of the upper gallery measures, in a straight line, 140 feet, or about 56 steps. Our experiments were first made in the empty hall ; and observations were subsequently made when the hall was full of people, during a lecture, when I took up various positions at different distances from the speaker, and noted the degree of distinctness with which different sounds were heard.

In the empty hall, sounds pronounced separately are understood further and more clearly than is the case when the hall is filled, because the resonance of an empty room is greater, and more favorable to perception of single sounds. But when several sounds are uttered in rapid succession, or a whole sentence is spoken, the same resonance greatly interferes with hearing, for it adds much to the strength of those sounds which are composed of the greatest number of partial tones, namely, the vowels, and also reflects them powerfully. These reflected vibrations of the loud vowels produce an after-sound (echo) which reaches the ear almost simultaneously with the consonant next following, and therefore conceals the weaker sound of the latter. In the hall filled with people the phenomena of resonance are much dimin-

ished; the clothes of the audience greatly dampen the sound; and the sound-waves, striking upon the irregular contours of the human figure, are dispersed much more than they would be by a flat wall, whereby the effect of echo is diminished.

In whispered speech we have the advantage of a similar dampening of the vowel-sounds, practised by the speaker himself; for in this form of speech the sound-waves that reach the ear have much less difference of amplitude than those of vocal ("loud") speech. If, for example, we pronounce the vowel U in the open air, aloud and strongly, the ear distinguishes it at a distance of 280 paces, while the F sound, pronounced alone, is scarcely audible at 67 paces; but if we whisper the U, its force becomes nearly as feeble as that of the F sound; the reason of which lies in the altered acoustic character of the vocal instrument which gives birth to the vowel-sound. The difference in intensity between the vocalized I (English long E) and the G molle is very considerable (= 300 : 130). The whispered I has the greatest similarity to the G molle, and almost the same force; both are produced from a resonant cavity (the mouth), which has the same shape in both cases, and whose proper tone is allowed greater prominence when the words are whispered; the pitch of the two sounds is therefore about d^{iv}. Further, when we pronounce the word *Ross* aloud, we have three sounds of very different pitch and intensity:—

	Fundamental tone.	
R —	bass c	— 41 paces.
O —	b^{i}	— 350 "
S —	c^{iv}	— 175 "

If we whisper the same word, the vowel O is so much weakened that it falls far below the S sound in intensity, while the latter and the R sound retain their full force. The word *café* presents the same alterations in force. If we speak it aloud:—

	Fundamental tone.	
A —	b^{ii}	— 360 paces.
E —	b^{iii}	— 330 "
F —	a^{ii}	— 67 "
K —	d^{ii}	— 63 "

If we whisper, A and E will rise but little above the force of F and K. In whispering we dampen the vibrations of the larynx

very much, while the position of the mouth which characterizes the vowel-sound, and the resonance of the oral cavity, remain the same as in vocal (loud) speech. The self-sounding consonants, which originate from the mouth without assistance of the larynx, will therefore scarcely change in intensity when whispered. This greater uniformity, or rather, this great diminution in difference between the several intensities (or breadths of sound-waves), gives an important advantage to the whispered voice as a test of hearing.

The experiments made in an empty hall show that all the vowels, and of the self-sounding consonants the R lingual, K, T, F, S, Sch, and G molle, when pronounced singly in succession, can be plainly distinguished in the most remote part of the room, at the distance of 140 feet or 56 paces; the B sound alone was heard at 36 paces; the H sound only at 12; but either of the two latter was heard plainly, sometimes at the furthest point in the hall, when combined with vowels (as Ba or Ha); the same is true of the sound-borrowing consonants when joined to vowels, as the syllables La, Ma, Na, though Wa could not always be distinguished from Ba, owing to the resemblance between W and B. Connected sentences, spoken slowly and with the whispering voice, were understood plainly at the distance of 130 feet; so were sentences spoken aloud with the same slowness. When spoken at the rate of ordinary conversation, there arose a confusion between the sounds coming from the speaker and the reflected sounds, so that little was heard besides vowels and hissing sounds; this took place at a distance of 80 feet. When the hall is full of people the perception of conversational tones is rendered easier, but the speaker cannot exceed a certain limit of rapidity without becoming unintelligible.

From this may be deduced a practical rule for lecturers; the larger the hall, and the smaller the audience, the more slowly ought the speaker to utter his words; at the same time he should dampen his vowel sounds as much as possible, and give his chief attention to developing the pronunciation of the self-sounding consonants. The singer who gives a correct and resonant pronunciation to his consonants, formed mainly by the mouth, will not only lessen the strain upon his larynx by such momentary intervals of rest, but he will also increase the character and

effectiveness of his performance; we judge of the development of a singer not only by the manner and style in which he brings out his tones, but also by the more or less complete and harmonious education of his pronunciation. Preachers in large churches, who usually have to contend with the excessive resonance of the building, learn by practical experience to employ a slow *tempo* in their utterance. Specialists in our department know, likewise, from experience, that very deaf persons understand us not better, but worse, as we raise the force of our voices; we therefore usually employ a slow and medium tone in speaking with deaf persons. When we raise our voice very much, it is only the vowels that receive any considerable accession of force, which simply serves to overpower still more the consonants, which cannot be greatly increased in force. The acoustic properties of the different rooms in which we speak are so extremely variable, and so very dependent on the accidental noises from the street or from adjoining rooms, that it is hard to set up any standard for the average normal hearing-distance of the healthy ear. In my suite of apartments, which have folding-doors opposite to one another, I assume as the average normal hearing-distance a length of 60 feet in the case of whispered words, by daytime, when the accidental noises are not too loud. At this distance even the most difficult combinations of consonants—as in the word "Frankfurt"—are understood by persons with normal hearing.

In order that an audience may be placed in the best conditions for understanding the words of a discourse or of a song, the greatest distance from the platform to the last seat in the auditorium must not exceed 125 feet; the room must be longer than it is broad, and about as high as broad; the material should be a stone, as little porous as possible (wood gives altogether too much resonance to the vowel-sounds); smooth walls are to be shunned where possible, but a number of galleries and pillars are desirable on account of the diversity of direction they give to the impinging waves of sound, and the consequent diminution of resonance. A vaulted wall, to serve as sounding-board, placed from 8 to 12 paces behind the speaker's desk, or directly behind the platform, is also useful.

Some Acoustic Remarks upon the R Sounds and the G Molle.

In regard to the special study of the acoustic character of the sounds heard in speech, I would refer the reader to my work above mentioned ; I add, however, some investigations concerning the rough guttural Ch, and the guttural R (R pharyngeale) of the Lower Saxons, which are almost identical ; the R uvulare and the R laryngeale, the soft Ch (after e and i),* and its equivalent the G molle ; which I was unable to describe fully in that work.

When the R linguale is artistically well formed, so that the current of air puts the tip of the tongue in regular vibrations, while the larynx and the pharynx are at rest, we perceive a tolerably harmonious combination of several deep tones, $C^{-3}+C^{-2}+C^{-1}+C^{0}$, of which C^{-3} and C^{-2} are especially prominent. On account of the low pitch of the ground-tone of the R linguale thus formed, the intensity of the sound cannot be great. We were able to distinguish R linguale at 41 paces.

Another species of R sound is that which is in some sort a combination of this first kind (formed only by the vibrations of the tip of the tongue and the resonant tone of the mouth) and that sound of R in which the tip of the tongue and the vocal chords or larynx are simultaneously thrown into resonant vibrations ; this sound might be named R laryngo-linguale. In pronouncing it, the vibrations of the larynx give a pretty clear and sharp tone, depending for its pitch upon the position of the vocal chords ; the whole sound is not unpleasant, is quite harmonious, and is therefore much liked by good singers. Its intensity, as is easily understood, much exceeds that of the deep and obscure R linguale, and it reaches to about 90 paces, heard in the open air. In some dialects the sonorous vibrations of the larynx are associated with corresponding vibrations, not of the tip of the tongue, but of the uvula ; if these are executed well and fully, there arises a sound, very like the preceding one, not without beauty, and quite sonorous ; its pitch and intensity are not essentially different from those of the preceding, because the uvula is simply substituted for the tip of the tongue as the vibrant portion of the instrument. This sound might be called R laryngo-uvulare.

Faber, in his talking-machine, formed the R sound by causing

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* Not an English sound.

the larynx to vocalize, while a burr-wheel (schnurrädchen) like the child's toy (wasserpfeifchen), placed close to the larynx, was set in motion by the current of air.

The fourth species of R sound, in tone closely resembling the so-called rough R pharyngeale, the throat R of the Lower Saxons, is identical with the throat sound Ch, the so-called rough Ch (following the vowels, a, o, u, as in the words: Ach! Bach, Joch).*

In forming this sound the current of air coming from the lungs puts the organs of the fauces, especially the uvula and the arches of the palate, in vibration; by this means two tones are produced, standing in a very inharmonious relation to each other, one deeper, produced by the vibrations of the uvula, and the other higher, probably originating from the arches of the palate; with these are associated several over-tones, likewise inharmonious, in consequence of the current of air being irregularly broken by the fauces. From such a mixture, of course, nothing can arise but a very disagreeable sound (the most unpleasant and inharmonious in the German language), which no speaker or singer ought ever to employ in the place of the R linguale or the R laryngo-linguale; if he has to pronounce the rough Ch, he should at least give it as weak and soft a sound as possible.

The pitch of the so-called soft Ch (after e, i), and of the G molle, corresponds nearly to that of the vowel I (German), that is to d^{iv}; the resonant cavity of the mouth has almost the same form and size as in the case of the vowel I. The intensity of the G molle lies between that of the Sch and the S sounds, and was distinguished at the distance of 190 paces in the open air.

From these considerations it will be evident that, in testing the hearing, those sounds are of the most importance which have by themselves a well-defined resonant quality, and can be presented to the ear to be tested with a definable tone of their own. Such are the vowels, and the consonants which I have named self-sounding; the deep-toned R linguale (less desirable are the other forms of R, because they give undue prominence to other higher tones), the B, K, T, F, S, Sch, and G molle. By a proper use of this series, we can obtain fairly accurate information as to the

* This sound is not found in the English language.

capacity of the ear for distinguishing sounds within a range of 8 octaves ; we moreover employ all possible degrees of intensity and timbre, from the poor, empty B sound, which approaches the so-called simple sounds, to the very harmonious and rich Sch sound with its chord of three notes. In deciding upon the results of our tests, all the acoustic qualities of pitch, timbre, and intensity must be considered, in order to assign defects in perception to their proper causes in the condition of the ear.

In doing this, we ought to pay special attention to the acoustic character of the meatus and membrana tympani,* which, like a little sound-collector, strengthens those tones and sounds which approach its proper tone (nearly e^{iv}), or which give harmonies of the latter. Hence it follows that the sounds S and Sch, as well as the G molle (pitch = d^{iv}), on account of this property of the region of the meatus and membrana tympani, are transferred, under especially favorable conditions as to force, to the sound-perceiving apparatus.

Speech is the most important means of testing the hearing, for the further reason that it possesses many sounds which are far weaker and more delicate than the tones of other instruments. For example, the pianissimo of a violin can be heard in the corridors of our concert-hall, when it is played upon the platform ; at which distance a large number of spoken sounds are inaudible.

This difference in the strength of the tones of musical instruments, as compared with the sounds of the voice, explains the apparent contradiction that deaf persons assist at concerts, and govern their instruments with perfect correctness, and can discriminate quite accurately the tones of the instruments of the orchestra, while they understand spoken sounds so poorly as to fail to distinguish B, H, K, T, and F at a distance of 8 feet. For the classification, diagnosis, prognosis, and treatment of diseases of the labyrinth, I consider the above method of qualitative testing of the hearing by means of the self-sounding consonants as quite indispensable. In what is to follow, I shall set forth the results of trials made upon patients, and shall attempt to analyze more closely the affections of hearing.

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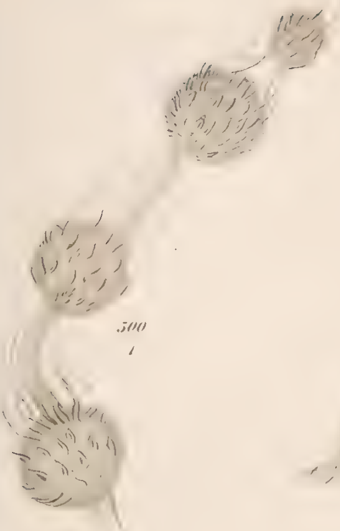
* Cf. Sprache und Ohr, p. 186.

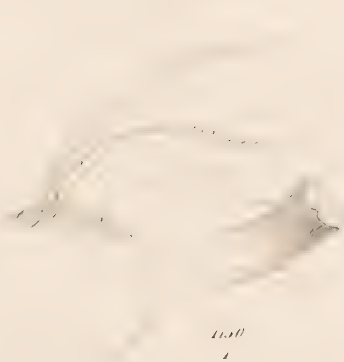
Tab. I.

Fig. 1.



500/1

Fig. 2.



1150/1

Fig. 3.

375/1

MYRINGOMYCOSIS ASPERGILLINA IN THE YEARS 1869–1873, ACCORDING TO PERSONAL AND FOREIGN OBSERVATIONS.

(With Fig. 3, Tab. I.)

By R. WREDEN, M.D., of St. Petersburg, Russia.

(Translated by Charles H. Burnett, M.D., of Philadelphia, Pa.)

After I had made my first observation of a fungous growth in the ear, in November, 1864, I reported, in December, 1866, six other cases,* in August, 1867, ten cases,† and in December of the same year fourteen.‡ At present the number of cases of myringomycosis aspergillina which I have observed amounts to 74. Besides these, within the last five years numerous contributions to the literature of this form of disease of the ear have been made by various aurists of Europe and America, all of which demand, at this time, a more complete consideration. At the outset I desire to call attention to a very important circumstance, viz.: that in all the seventy-four cases which I have collected, I have found only the two forms of *Aspergillus* described by me (*A. flavescens* and *A. nigricans*), excepting in one solitary case, a description of which I now give:

Mr. P., thirty-seven years old, came to me on the 7th of March, 1871, with the statement that he had noticed for two weeks hardness of hearing and tinnitus in his right ear, which were accompanied by a sensation of fulness and painful pressure in the ear. His family physician had already syringed his ear on the supposition that it contained a collection of cerumen; but nothing had come out. Within two days of his visit to me severe pains in the ear had set in, which had deprived him of his sleep at night, and at last had induced him to seek the aid of an aurist. The patient was unable to assign any probable cause for his suffering. Hearing for the watch 3″; bone conduction good; tuning-fork placed on

* Archiv f. Ohrenh., 1867, Bd. iii., Heft 1, pp. 1–21.

† Sitzung vom 27 August, 1867, des ersten internationalen Congresses der Aerzte zu Paris. (See Comptes Rendus of the same, as well as Comptes Rendus de l'Academie des Sciences, Aug. 29th, 1867.)

‡ Die Myringomykosis aspergillina und ihre Bedeutung für das Gehörorgan. St. Petersburg, 1868.

the head resounds sharply in the affected ear. An ocular examination of the ear revealed the presence of a blood-red mass in the meatus, which by two injections of water was brought out in the form of a red plug. The membrana tympani appeared uniformly red, and its cuticular layer swollen. The vessels of the malleus were enlarged. No pyramid of light. The tinnitus was diminished after the syringing. The pain also disappeared. The hearing increased to 30″. After using, for six days, an alcoholic solution of tannin, the ear appeared perfectly healthy, and there has never been, to date, any return of the malady.

Although the macroscopic appearance of the mass which had thus been removed left no doubt as to its fungous nature, the dark purple-red color showed conclusively that in this case we had not met a growth of either *A. flavescens* or of *A. nigricans*. It must therefore be of a kind of fungus heretofore unseen in the ear by me. The microscopic examination confirmed my supposition, for it revealed the presence of a fungus richly supplied with capsular sporangia or asci, which, on account of its intense red color, I named for the present *Otomyces purpureus* (see the accompanying plate. Tab. I. Fig. 3).

The mycelial layer consists of delicate, very transparent, colorless, branching, and septate rootlets, from which the stronger fructiferous hyphens arise. These fertile hyphens, with double contour, manifest at different places, like the fructiferous hyphens in the varieties of Aspergillus already found in the ear, transverse septa. The width of the broadest of them is 0.00572 mm.—0.00715 mm. The wall of the fungus, that is, the double contour or outline, is of a bright yellowish red color, and is 0.00143 mm. thick. The fruit end of the hyphen is composed of a comparatively very large, red, round, vesicular sporangium, which consists of a thick-walled capsule, and a number of round spores which completely fill the cavity of the capsule. The diameter of the large sporangia is 0.0572 mm.—0.06435 mm.; that of the smaller ones is 0.02145 mm.—0.0429 mm. The thickness of the capsule wall = 0.00143 mm.—0.00214 mm. Upon the younger less developed sporangia we are able to distinguish, between them and their hyphens, a separation, by means of a plane or somewhat arched septum.

These unripe sporangia are of a brighter, yellowish-redder color, have a thick wall, and are filled with a finely granular pro-

toplasm, from which, as development advances, the round-celled spores are developed. The spores are small, bright-red (by transmitted light) round cells of a diameter varying from 0.00286 mm. to 0.00429 mm. which before germination show only a simple smooth contour and bright-red homogeneous contents. The germinating spores, on the other hand, show a distinctly double contour or outline and a dark, eccentric nucleus, the spores having now attained a diameter of 0.00715 mm.—0.00858 mm. After the rupture of the ripe sporangium the spores pass into the open air and distribute themselves over the surrounding neighborhood. So far as relates to the form of its organs of fructification, the above-described aural fungus shows a similarity with the "Ascophora elegans," a picture of which I have given in my work entitled "Die Myringomykosis." However, aside from the difference in color of these two forms of aural fungi, the following essential morphological differences exist between them:

The hyphens of the *Ascophora* described in Von Troeltsch's case are considerably broader than those in my fungus; for the former have, according to measurements made by me on Schenk's preparations, a diameter of 0.02145 mm.—0.03575 mm. Furthermore, the hyphens of Von Troeltsch's aural fungus, like all Macorines, have no transverse septa, whereas the hyphens in my fungus have such septa.

The sporangia of the *Ascophora* are, on the other hand, much smaller; for the majority of them have a diameter of 0.0143 mm. —0.02145 mm., and only a very few ever attain a diameter of 0.05005. Besides, the sporangia of Schenk's preparations have not such thick walls, *i.e.*, the capsules do not manifest such a broad double contour as the sporangia in my preparation. The spores, too, in Schenk's Ascophora are considerably larger than in mine, for they have a diameter of 0.00715 mm.—0.00858 mm. They do not completely fill up the sporangium, are produced in much smaller quantity, and show (500 diameters) even in the sporangium a very marked double contour, whereas the spores of the *Otomyces purpureus* show a similar contour for the first time at germination. In order to obtain a more satisfactory determination of the nature of my red aural fungus, I applied to our distinguished mycologist, M. Woronin, who very kindly subjected my preparation to a most careful examination.

He pronounced my *Otomyces purpureus* essentially different from the *Ascophora* of Schenk, which belongs to the mucorini, whereas my aural fungus appeared to him to be the ascomycete or perithecal fruit either of the Penicillium or of the Aspergillus.

This question could not be positively decided, according to Woronin, unless we could cultivate the aural fungus under the microscope. But to do this we needed a fresh, germinating fungous mass, whereas mine was already too old for such a purpose; since, however, only Aspergillus, and no Penicillium, has ever been found in the ear, I felt justified in supposing that my *Otomyces purpureus*, in all probability, represented the utricular form, that is, the Ascomycetes of the Aspergillus, and not of the Penicillium. It is well known that the *Aspergillus* possesses two forms of fructification, utricular fruit, representing the perfectly developed form of the fungus, and the conidianiferous form (globular sporangia studded with sterigmata which throw off the spores), representing the incomplete development of the fungus. If all the external conditions requisite for perfect development are present, the mycelium first produces the stylospores, and later, when they are near the termination of their development, asci are produced, with the ripening of which the mycelium and the entire fungous layer assume a yellow or yellowish-red color, that is, an altogether different appearance. If, on the contrary, the external conditions are only partially supplied, the development of the Aspergillus will be incomplete, *i.e.*, the mycelium will produce only *conidia* and no *asci*. The converse of this, viz., the production by the mycelium of asci only, and no conidia, has never yet been found. Before the correlation of these two forms of fructification was known, they were considered organs of two widely different kinds of fungus, and the form corresponding to the ascophores was named *Eurotium*, and the other, the conidianiferous form, was called *Aspergillus*. So far the Aspergillus has been found in the ear of man and beast only with the conidia, and never with the *asci*.

After I had been put in the right path concerning my aural fungus, by the explanations of H. Woronin, I again investigated the false membrane which had been removed from the ear, upon the supposition that perhaps some conidianiferous elements or stylospores might be found in it, which would serve to determine

whether the perithecal fruit or asci which had been found, belonged to the *Penicillium* or to the *Aspergillus*. My expectations were not disappointed. In the interior of the false membrane I found several places which were characterized by a dark, almost black color, and were readily distinguishable from the surrounding dark-red mass. I examined these spots by the aid of the microscope, and found, in addition to a multitude of germinating spores and ripe utricles or asci, completely developed stylospores or conidia of *Aspergillus nigricans.** There can be no doubt, therefore, that in this case of myringomycosis, the Aspergillus in the ear had attained to its highest form of development; for not only had conidia or stylospores been produced, but also utricles or asci had been developed. This case is therefore unique, and possesses all the greater interest because heretofore the utricular form of the fructification of Aspergillus, *i.e.*, spores arranged in sacs, or asci contained in a perithecium, has never been found in any organ of man or beast. *The Ascomycete of the Aspergillus nigricans, that is, the highest form of the specific aural fungus, is herewith made known.*

Since the publication of my last treatise on Myringomycosis, five years have elapsed, and during that time I have collected, besides the case described above, fifty-nine new cases illustrative of the growth of *Aspergillus*, which have furnished me with many valuable data for the determination of the true nature of myringomycosis. Before I proceed to state my own views, which I have gained from these observations, I deem it proper to give a short sketch of the experiences of other authors concerning this form of disease of the ear. Previous to my first observations in this field of mycology there were but four cases of fungous growth in the ear on record (Mayer, Pacini, Cramer,† and Schwartze), all of which presented examples of Aspergillus; but, after my publi-

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* As recently as the 18th July, 1873, I have examined the fungous mass, which I had preserved in a glass case for two and a half years, and after the lapse of so long a time I found that the stylospores, or conidia, and the asci were still perfect. During this time many more black spots have formed in the fungous mass, which demonstrate an after-growth of conidia, or stylospores, whereas no new asci have been formed.

† Carl Cramer: "Ueber eine neue Fadenpilzgattung im Ohr, *Sterigmatocytis autacustica*." Vierteljahrschrift d. naturforschenden Gesellsch. zu Zürich. 1859 and '60. The description and illustration lead to the recognition of the *Sterigmatocytis autacustica* as a variety of *Aspergillus* closely allied to the *Aspergillus nigricans*.

cations on this subject, the following series of kindred observations were made: F. E. Weber* reported three cases of fungous growth in the ear, among them an ambilateral one, all of which manifested the same subjective and objective symptoms as mine. In no instance was the growth of the fungus accompanied by otorrhœa. In one case (2d) there had been, some time previous, an inflammation of the tympanum, with perforation of the membrana tympani; in another (3d), furunculi had preceded the fungous growth in the meatus, and with the other (1st) there was no account given of any previous affection in the ear. Another interesting circumstance in the cases recited by Weber is the formation of dark green, velvet-like patches of *Aspergillus glaucus*, whereas I have found in the ear, so far, only the black or yellow variety of bluish-green spadiceous mould. It is unfortunate that the botanical description, as well as the plate which accompanies the aforesaid history, is very deficient and obscure, while the description of the latter fully demonstrates the author's inexperience in mycological subjects. The headless condition of the hyphens (dd in the figure) Weber attributes to the action of the borax. Should not these "tubes, as they appeared to be after treatment with a solution of borax," be simply fragments of hyphens which had lost their heads by the use of the needle in preparing them for the microscope?

J. Orne Green,† of Boston, has published two cases of Myringomycosis aspergillina.

The first case occurred in a patient who was under treatment for chronic catarrh of the middle ear. Pain did not set in until the removal of the parasitic false membrane. Otorrhœa was not present at any time.

The other case‡ is very interesting, because it occurred in the author's own ear, and, so far as concerns the ætiology, symptomatology, and therapeutics, furnishes a complete confirmation

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* F. E. Weber: "Ueber Parasiten im äusseren Ohr, Otitis Parasitica." M. f. O., 1868, Bd. ii., H. i., p. 10–13.

† J. Orne Green, M.D.: "A Parasitic Growth in the External Auditory Meatus" (Boston Medical and Surgical Journal, Nov. 19, 1868).

‡ J. Orne Green, M.D.: "Two Cases of Parasitic Growth (Aspergillus glaucus) in the External Auditory Meatus," (Transactions of American Otological Society, 1869, p. 23–26).

of the description I have given of similar cases. Orne Green had suffered frequently in the course of several years from furunculi in the meatus auditorius; but two years before the appearance of the parasitic affection he had been entirely free from all ear-disease.

The growth of the fungus was attended with a slight serous discharge from the ear, a feature of the disease to which I have called attention in my monograph ("Die Myringomykosis," etc., pp. 38, 39). The author gives no special botanical description nor drawing of the aural fungus in his own case, but merely states that it was identical with the fungus which I described and illustrated in my first treatise on the subject (Arch. f. Ohrenh., 1867. Bd. 14, pp. 1–21, tab. 1).

On the other hand, St. John Roosa,* of New York, has illustrated his two cases of Myringomycosis aspergillina with a very good description of the microscopic appearance, and a drawing of the aural fungus by William B. Lewis. In this instance we find a confirmation of the fact that the morphological properties of the A. flavescens and A. nigricans—one case of each of which Roosa has seen, are the same on that side of the ocean as on this.

The symptoms of the disease correspond with those which I have observed. Roosa, like Orne Green, did not observe any purulent discharge from the ear before, during, nor after the presence of the fungus in the ear.

Clarence J. Blake † has lately said that it is very difficult to offer anything new in connection with the ætiology and symptomatology of myringomycosis, and therefore he communicates the histories of only two of his five cases of fungus in the ear, because these two furnish a peculiarity not yet described. The peculiarity of Blake's case is the following:—A medical student, suffering from a simple catarrh of the middle ear, was attacked first by a characteristic myringomycosis, accompanied by a growth of typical Aspergillus nigricans. This case relapsed, and then a bastard form of Aspergillus with Penicillium was found

* St. John Roosa: "Two cases of the Growth of the Aspergillus glaucus in the External Auditory Canal" (Am. Journal Med. Sciences, cxvii., N. S., Jan., 1870, p. 105–113).

† Clarence J. Blake, M.D.: "Parasitic Growths in the External Meatus" (Transactions American Otological Society, 1871, pp. 30–33).

in the yellowish-white layers of the fungus in the meatus auditorius; but the false membrane which covered the membrana tympani and the inner end of the auditory meatus consisted of pure A. nigricans, from which the conidia had already fallen.* The hyphens with a double outline are those of an Aspergillus. A special botanical description which would permit of a recognition of any characteristic or morphological features peculiar to Penicillium is entirely wanting in this case; and I am forced, therefore, for the present, to refuse to accept this as a proof of the circumstance heretofore unestablished, viz., that Penicillium, like Aspergillus, grows in the ear to the development of sporangia. Blake's other case was in connection with ceruminal deafness, in which the obstructive mass of wax was mixed with epidermis, and covered with a light-brown powder, which, under the microscope, was seen to be perfectly developed *Aspergillus flavescens*. There is neither description nor drawing of this aural fungus given, and there remains but the statement that in Blake's cases the fungus was not developed in a purulent inflammation of the ear, nor was it followed by the formation of pus.

F. Bezold,† of Munich, has described a case of myringomycosis which occurred in a curate 56 years old, who had suffered for seven or eight years with excessive hardness of hearing (probably nervous deafness). The fungus was found in both ears, and proved to be, according to Prof. Radlkofer, a specimen of *Aspergillus nigricans*, which is well described by Bezold. Before the fungous mass was removed from the ear, loudly spoken words were heard very indistinctly on the left side, and on the right side only the sound of the words was distinguished. After the removal of the mass of fungus—loud words heard in left ear, 1′; right, ½′. The watch was heard neither in the ear nor by bone-conduction. The after-treatment, viz., the air-douche, by means

* The sporangia of the A. nigricans are distinguished from those of A. flavescens, and other forms, by the fact that in the first the sterigmata cover the receptaculum on all sides; whereas, in the latter form the inferior fifth or fourth of the receptaculum is entirely free from sterigmata. (See "Myringomykosis," etc., pp. 34–35.) This same freedom from sterigmata, as above described, is found in Hallier's copulation forms of Aspergillus and Penicillium, to which is added the notches in the receptaculum for the penicilliate distribution of the sterigmata.

† Ein Fall von Aspergillus nigricans im äusseren Gehörgange" (Archiv f. Ohrenh., 1869, Bd. v., pp. 197–201).

of the catheter, produced no improvement in hearing. "The course of this case of fungous growth in the ear was quite normal, and was unaccompanied by otorrhœa. There was no irritation caused by the presence of the fungus, although it is asserted by Wreden that irritation is a constant characteristic of this disease. In his cases itching and pain in the ear are always present, and very often the pain extends to the entire side of the head, and there is throbbing in the ear. But in my case there was no subjective symptom excepting hardness of hearing, and constant noise, resembling that of a distant mill; and after the removal of the fungus there remained only a slight hyperæmia and swelling, with no loss of epithelium." The absence of subjective symptoms, that is, of pain, must be attributed in this case to anæsthesia of the trigeminus, which to a greater or less degree accompanies similar cases of excessive nervous deafness; and we may also find an explanation for the relatively mild objective manifestation* of inflammation of the membrana tympani in the diminished sensibility of the cutis of that organ. So far as the ætiology is concerned, Bezold's case is of interest to us, inasmuch as the patient stated that "he spent a large portion of each day in a room on the ground-floor, the walls of which were so damp in the spring that the paper had fallen off in several places."

F. Steudener,† Instructor in Pathological Anatomy in Halle, reports two new kinds of aural fungi, which he obtained from Prof. Schwartze and examined under the guidance of De Barry. He also adds to the botanical description a series of adverse remarks upon "Myringomycosis," although he has not made any special study of this form of disease, and makes but the vaguest statements concerning his "new aural fungi" in these words: "The symptoms which these fungi produced agreed fully with

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* These appearances are thus described:—The inner third of the auditory canals moderately swollen and red, so that the edge of the membrana tympani cannot be seen. In the position of the manubrium of the malleus there is a vascular tumefaction extending downwards from the visible short process of the malleus, growing smaller as it descends. The periphery of the membrana tympani resembles a rusty-red circle; but the portion of the membrane between the manubrium of the malleus and the periphery of the membrane is gray. The epithelium is intact, as it is in the meatus. "Similar inflammatory swelling and hyperæmia usually produce pain in ears which are not anæsthetic."

† F. Steudener: "Zwei neue Ohrenpilze nebst Bemerkungen über die Myringomycosis" (Archiv f. Ohrenh., 1869, Bd. v. p. 163-168).

those already known, as connected with the growth of aspergillus in the ear." Unfortunately, however, of these two species of fungi announced as new, in reality only one is new. It was considered by De Barry to be an imperfectly developed "Tricothecium roseum," Lk. The other fungus, according to description and the drawing, is nothing more than the old, well-known aural fungus *Aspergillus nigricans*, which, however, Steudener produces as the *Aspergillus niger* of Tieghen. It is indeed very remarkable that at the beginning of his treatise (l. c., p. 163) Steudener speaks of two new forms of fungi, "heretofore unobserved in this locality" (the auditory meatus); but four pages further on he says: "Probably we must conclude that the *Aspergillus nigricans* described by Wreden is identical with the *Aspergillus niger*." It would have been much better if he had frankly said that the *Aspergillus* described by him was indeed (not probably) nothing more than *Aspergillus nigricans*, and no new form of aural fungus described for the first time by him. Instead of that, Steudener says on the same page (163): "In any case, this fungus is identical with the *Aspergillus fumigatus*, Fres., and with the *Aspergillus nigricans* of Robin. (?!)"

In this connection the word "probably" would be more in place than the words "in any case;" for, after all, we have here merely a supposition, which, for the sake of emphasis, is arranged in the guise of a positive assertion.

To every well-informed reader this assertion of Steudener will serve as a proof that he does not hesitate to condemn in a categorical manner matters of which he knows nothing at all. If Steudener had ever seen either a description or a drawing of Robin's Aspergillus, he would have known that it was called *nigrescens*, and not *nigricans*, and that the hyphens of this fungus form a characteristic diagnostic point of difference between my *Aspergillus nigricans* and the Aspergillus of Robin.

He must also have known, from a perusal of the same "Myringomycosis" which he has honored with some "remarks," that Robin had seen my preparations of aspergillus, and had not considered them identical with his *A. nigrescens*, but, on the contrary, had made a special communication to the Paris Academy concerning my new aural fungi. (Comptes Rendus, 29 August, 1867).

Defective knowledge of his subject, however, does not prevent Steudener from passing an adverse judgment, and he does not even take the trouble to state his reasons. We are told that my botanical description is inaccurate, my experiments in the cultivation of the fungus are not sufficiently convincing, and that my *Aspergillus flavescens* appears to him to be identical with the *A. flavus* of Bonorrden! I also appear, according to him, to have gone too far in saying that the growth of fungi is a parasitic affection, and Steudener then produces reasons for this assertion, which I shall consider further on. The only valuable result of Steudener's labors is the establishment of the fact of a new fungus, heretofore unobserved in the ear—viz.: the "imperfectly developed *Tricothecium roseum*," Lk.; but we are also forced to express our regret that there is a total want of any description of the disease caused by its presence in the ear.

J. Böke, of Pesth, has reported five cases of Myringomycosis, three of which are fully described in his Hungarian "Treatise on Otology," and two in the "Hungarian Medico-chirurgical Press."* His experiences completely corroborate the sketch of "myringomycosis" already given by me, as well as my views of the ætiology, prognosis, and treatment of this form of aural disease. In none of his five cases was otorrhœa present, and he lays stress on the rarity of fungous growths, as attendants or as sequelæ of aural disease, as well as the non-occurrence of such growths "during an otorrhœa." He furthermore substantiates my statement that the removal of the false membrane from the membrana tympani is accompanied by intense pain and imflammatory symptoms. He also defends the view that a fungous growth in the ear is no meaningless accident, but an independent, parasitic disease of the ear, having its chief seat on the membrana tympani. When alluding to the ætiology of the disease, Böke says that in all of his five cases he examined the "hearing-liquor," which had been poured into the ear in each case before the occurrence of fungous growth in the ear, and found, with the aid of the microscope, numerous spores, which in eight days after they had been sowed upon a piece of lemon-skin produced fungi similar to

* J. Böke: "Zwei Fälle von Pilzwucherungen am Trommelfell (Myringomycosis)" (Hungarian Med.-chirg. Press), 1869—9, 12, 16, 19.

those found in the ear. So far as the mycological diagnosis is concerned, he openly confesses that he is not in possession of knowledge sufficient to enable him to make a ready distinction of the various kinds of the lower orders of fungi, and in his three first cases a mycological description is entirely wanting. He found in these cases only unripe thalli and spores, which were not used for cultivation by him. It is therefore entirely undecided what form of fungi produced myringomycosis in his three first cases. In his two last cases he is of the opinion that he has found two distinct varieties of fully developed forms of fungi, which he considers as *Mucor mucedo* s. *fuscus* (Fresenius), and the *Aspergillus microsporus* of Hallier. Since, however, his article is entirely wanting in diagrams as well as any exact botanical description of the aural fungi found in these cases, we must, for the present, accept his mycological diagnosis with great caution. This caution on our part will appear all the more justifiable, since the author confesses his want of skill in such matters, and unfortunately has not quoted the authority of any well-known name in the field of mycology as a guarantee for the correctness of his classification of the aural fungi.

H. Schwartze has made no new communications upon fungous growths in the ear since the cases published in the "Archives of Otology" (Bd. ii., p. 5), and to which I have already alluded. It is very evident that he has seen such cases of disease of the ear in the meantime, from the aforesaid article of Steudener and from the protocol of the first Otological Convention, which was held at the time of the session of the 42d convention of the Naturalists and Physicians of Germany, at Dresden, 1868.*

At the fourth session of the convention, 23d September, 1868, during the consideration of the subjects of paracentesis of the membrana tympani and of fungous growths in the ear, Schwartze stated that the latter were by no means rare, but he failed to give the number of cases upon which he based his statement. He also stated that the fungi which he had found invariably belonged to the species Aspergillus.

Furthermore, in opposition to my views, he stated at that time and subsequently, in alluding to my "Myringomycosis asper-

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* Archiv f. Ohrenh., Bd. iv. p. 154–155.

gillina,"* that the growth of fungi in the ear, according to his views, is purely a secondary manifestation of disease, an accidental symptom ;† and that Virchow's term, "Otomykosis," is more appropriate than my term, "Myringomycosis."

A. Lucæ has not yet published his cases of fungous growths in the ear ; but that he has observed such cases frequently is known from personal statements made to me, in the summer of 1867, as well as from communications upon the subject made to the first Otological Convention held in Dresden. In the fourth session of the convention already alluded to, Lucæ gave a description of the cases of fungous growth in the ear which he had observed, and among other statements he said, that "he had seen fungi grow in an otherwise healthy auditory meatus, and that he had never seen in his cases the simultaneous occurrence of otorrhœa."

A. von Troeltsch has not published any account of personal observation of fungi in the ear (with the exception of the case of Ascophora already alluded to), and in his "Treatise," 4th edition, pp. 94-95 and 120, he merely alludes to the subject, without offering any opinion of his own based upon personal observations. He seems, however, disposed to attribute a pathological significance to the formation of fungi in the ear.‡

A. Politzer § exhibited to the Medical Society of Vienna, 11th May, 1870, a very interesting preparation, in which one could readily see the penetration of the fungous growth into the tissue of the membrana tympani. In this specimen it was possible to trace the mycelial filaments, and the hyphens, between the circular fibres of the membrana tympani, as far as the edge of the sickle-shaped remnant of the membrane. This condition was corrobo-

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* L. c., Bd. iv. p. 285-287.

† This opinion of Schwartze is all the more remarkable because, to a certain extent, it is a contradiction of his views already expressed in the description of his case. (Arch. f. Ohrenh., 1865, Bd. ii. p. 5.) At that time he distinctly stated that "in all probability fungous growths may be found more frequently to be the cause of the well-known, severe, constantly relapsing, chronic inflammation of the external auditory meatus, with great accumulations of epidermis and exfoliation of the latter."

‡ "According to recent observations it appears to be no uncommon occurrence that inflammation of the auditory meatus is produced by the growth and accumulation of masses of fungus (Aspergillus) in the ear."—(Von Troeltsch's Lehrbuch d. Ohrenh., iv. Aufl., 1868, p. 94.)

§ A. Politzer: "Ueber pflanzliche Parasiten im Ohr." (Wiener Med Wochenschr., 1870, 28).

rated by E. Hallier. Other cases of myringomycosis have not been contributed by Politzer, so far as I know, although it appears from the report of the meeting that he had had many opportunities of making observations on the subject.

Hassenstein, of Gotha, has reported several cases of fungi in the external auditory meatus,* which are different from others already described, on account of their occurrence with otorrhœa; and they also show the safety and harmlessness of the alcohol treatment.

There is a great deficiency in the description of the first case. "A bookseller, who had a perforation of the left membrana tympani, following scarlatina, but on the right side no perforation until he came under treatment," manifested signs of fungous growth in the right ear, and subsequently in the left, during the application of nitrate of silver and sesquichlor. of iron to these parts. In the right ear the fungous growth extended to the membrana tympani; in the left ear it extended to the granulating surface of the mucous membrane of the promontorium, with more or less secretion, and exhibited the appearance of a bluish-green membrane, with its chief seat on the antero-superior wall of the meatus auditorius.

"The microscopic examination of the membranous portions removed from the ear revealed a closely woven mesh of mycelial filaments with sporangia, and sometimes (?) free spores."

There is an entire absence of any description of these mycelial filaments with sporangia, and we must be contented with the "bluish-green appearance" of the membranes removed from the ear during the use of nitrate of silver and sesquichlor. of iron, if we desire to suppose, with Hassenstein, the existence of Aspergillus glaucus in this case! The second case is still more deficient in its data, and is dismissed with these few words: "A similar brilliant result of the efficacy of alcohol, I obtained in a second case of chronic otitis media, with a large destruction of the membrana tympani and moderate secretion. Also, the occurrence of fungi, (which ?) in this instance, was attended with impairment of hearing and a sensation of constriction in the head; but a single ap-

* Hassenstein: Alkohol-Behandlung des Aspergillus glaucus in äusseren Gehörgangē. Zeitschr. f. Parasitenkunde von Hallier und Zürn, 1869, Bd. i., Heft 2, p. 111–113.

plication of alcohol was sufficient." Although, strictly speaking, we are unable to discover from these two cases, what kind of membranes Hassenstein succeeded in destroying, without return of the growth, by a single "pencilling of the affected localities with 90 per cent. alcohol," we are fully indemnified for this in a third case, in which Hassenstein, with Hallier's aid, found in the same ear three kinds of fungi, viz.: the *Aspergillus glaucus*, *Stemphylium polymorphum*, and Graphium penicilloides!! This occurred in a man who had suffered for about three years from an offensive discharge from the right ear, but in whom Hassenstein could not discover any perforation of the membrana tympani, "although at times, during the performance of the Valsalvian method of inflation, a peculiar shrill sound, similar to that of a strongly blown oboe, was heard." After the treatment had been continued for ten days, the patient manifested symptoms of an otitis externa acuta. "Upon examination the external ear was found to be painful, the integument of the auditory meatus was red and swollen, as well as the antero-inferior quadrant (perforation?) of the membrana tympani; upon the anterior wall of the bony portion of the auditory meatus, as well as upon the adjacent part of the membrana tympani, there lay a greenish-yellow secretion, which had an almost plush-like appearance. This peculiar appearance induced me to remove the secretion by means of a hard-rubber curette, and examine, what I thus obtained, with the microscope. The presence of a moderate amount of mycelium pointed to the fact that the peculiar appearance of the secretion was due to the presence of a fungus, and as at that moment Prof. Hallier called upon me, the matter which I had just obtained was used for cultivation upon a piece of disinfected cork, the result of which the aforesaid authority has already reported upon."

It is very evident that Hassenstein as well as Hallier found only mycelial filaments in the greenish-yellow aural secretion, which, as is well known, are also found in the mucous secretions of other cavities of the body, but possess no special pathological significance; whereas completely developed fungi, with organs of fructification, were not obtained by Hallier in this case until he cultivated the aural secretion upon a piece of cork.

The purity of this culture is not especially proven by the fact

that it produced three essentially different forms of fungi, viz: the Aspergillus glaucus, Stemphylium polymorphum, and the Graphium penicilloides. Involuntarily the idea occurs to our mind, that any other muco-purulent secretion would have produced the same results if it had been placed under cultivation.

There are no corroborative experiments quoted, and I believe that I have as good a right—perhaps greater—to call these three fungi "cork fungi," as "aural fungi." It is still unclearer to me why Hassenstein has devoted all his attention to the Graphium, and has presented it alone to the otiatric world "as a new fungus in the external ear," while he overlooks entirely the equally important Stemphylium. The title of his article should rather be, "Observations upon *Two* New Kinds of Fungi," etc. It must therefore appear, from all I have said, that Hassenstein's so-called fungous growths in the auditory meatus are totally different from the cases of myringomycosis already published, from the fact that Hassenstein's cases "occurred during otorrhœa." Furthermore, since all necessary scientific proof of the actual existence of a flourishing, fructifying species of fungus in the ear is wanting, such observations as have been made by him cannot be accepted by science as having any value.

Hagen has demonstrated to us lately how far one may err in a search for aural fungi. With untiring industry and zeal, Hagen * (in connection with Hallier †) made a series of observations, for two years (1869 and 1870) upon the cultivation of aural fungi, and at last contributed the results of his observations and experiments on the subject to the "Zeitschrift für Parasitenkunde" (13 Observations). He surely added one new fact to Otology, although it appears to have been unintentional on his part, viz.: that with the help of a potato and a little "nutritious

* R. Hagen: "Ein neuer Ohrenpilz (Otomyces Hageni)" (Zeitschr. f. Parasitenk. 1869, Bd. i. p. 199–202). "Zwei weitere Fälle von Ohrenpilz" (ibid., p. 368–374). "Weitere Fälle von Pilzkrankheiten des Ohres" (ibid., 1870, Bd. ii. p. 22–29). Fernere Fälle von Pilzkrankheiten des Ohres (ibid., pp. 232–241).

† E. Hallier: "Notiz zu vorstehender Arbeit über den neuen Ohrpilz, Otomyces Hageni" (ibid., 1869, Bd. i. p. 199–202). "Vorläufige Notiz zu vorstehender Arbeit" (ibid., p. 275). "Mittheilungen über die Ohrpilze, welche Herr Dr. R. Hagen in Leipzig zur microscopischen Untersuchung einsandte" (ibid., 1870, Bd. ii. p. 250–280).

fluid," any one may prove the existence of fungi of the most diverse kinds in the ear.. "Every yellowish-white excretion" in a purulent ear, and "every whitish-yellow mass" or "membranous lamella" in a non-purulent ear, were sufficient to arouse Hagen's suspicion of the presence of fungi, and induced him to place the suspicious product taken from the ear, under cultivation upon a piece of potato, without any preliminary microscopic examination, and then he proceeded to describe the fungi which had grown upon the piece of potato as "aural fungi." Only in his first case was the artificial cultivation of the fungi preceded by a microscopic investigation. But the account of this case is very deficient (l. c., p. 197). "I found at that examination (microscopic) fungi, of, to me, unknown species, but which closely resembled the Aspergillus nigricans of Wreden, although they were not exactly like it. I placed some of this mould-like matter upon pieces of cork. . . . The fungous forms which I thus produced induced me to make a request of Prof. Hallier that he would subject these fungi to the closest scrutiny, which he did with the greatest and most obliging readiness."

It can easily be seen from the "note" given by Hallier to this investigation of Hagen, that a grass-green patch grew from, or rather in, the place of the "yellowish-white" mass taken from the ear, which patch, according to the description and plate, presented all the features of a luxuriant growth of fructifying Aspergillus.

This last-named fungus is, so far, almost the only fungous growth which has been found in the ear, notwithstanding which it was described as an "heretofore unknown, new aural fungus," and the suggestion was made to call the newly found aural fungus the Otomyces Hageni!

In the second case the "whitish-yellow membranous lamellæ," before any microscopic examination of them was made, were placed upon a piece of orange-peel, upon which, in the course of a few days, "blue-green patches were found, which, according to Hallier's description (l. c., Tab. vi., Fig. 1–6), appeared to consist of forms of Aspergillus and Penicillium, usually found on mouldy orange-peel. Nevertheless, Hallier finds in this mould of an orange-peel a new and entirely unknown form of aural fungus, "which might temporarily bear the name of Aspergillus ramosus."

In the third case the white masses removed from the auditory meatus were sowed upon a piece of potato, which was covered in the course of a few days with a "grass-green patch of fungus;" Hallier found once more a hardy Aspergillus. "The fungus in the third case is identical with that of the first case. The Otomyces Hageni must have a very extended distribution." I have not the least doubt that the Aspergillus, that is, the Otomyces Hageni, has a very wide dissemination, but I cannot comprehend how any one can make such a deduction from *two cases!*

In the fourth case Hagen was more successful in his raising of fungi, for he found two varieties of aural fungi in the same patient, who, since early childhood, had suffered with polypi in the ear and destruction of the membrana tympani, as sequelæ of scarlatina.

After the removal of the polypi, by means of Wilde's snare, "small particles of a whitish coating upon the mucous membrane of the tympanum" were removed from the right and left ear, and were plaçed upon a piece of apple-skin.

In due time the piece of apple-skin, corresponding to the left ear, was covered with a patch of beautiful brown fungus, in which Hallier detected an Acrostalagmus (s. Stachylidium) parasiticus, while the piece of apple-skin corresponding to the right ear became gradually overgrown with a "blue-green" mass, which, according to Hagen, consisted of "beautiful blue-green Aspergillus," but according to Hallier was composed of Penicillium!

This confusion is further increased by Hallier's declaration:

"It must be expressly stated that these two forms of fungi had only gone as far as the formation of mycelium, and we have reason to suppose that they do not, in the forms found in the ear in these cases, advance as far as fructification!"

Unfortunately, however, Hallier had seen only the mouldy apple-skin and not the ears, and in the history of the case we find no statement that Hagen had subjected the "white excretion" of the mucous membrane of the promontory to any preliminary microscopic examination; wherefore Hallier's explanation loses all its force, and Hagen's "aural fungi" are transformed into "apple-fungi."

In the fifth case Hagen returns to the boiled potato, upon

which he had sowed the "delicate yellowish white excretion" from the ear of the patient suffering with otorrhœa and perforation of the membrana tympani, which had existed for five years, as sequelæ of measles. For ten days nothing grew on the potato, "Therefore I (Hagen) placed upon the preparation, on the tenth day, a few drops of a nutritious fluid, consisting of phosphate of ammonium, grape sugar, and water, and three days afterwards I saw distinctly the formation of a delicate mycelial web." Hallier considered the delicate, artificially fed foundling to be "a delicate, beautiful Aspergillus!" "but he is unwilling to express any positive opinion upon the specific nature of this fungus, not even a hint as to its species."

In the sixth case Hagen is forced to behold nothing grow for eighteen days upon the potato upon which the "white membranous deposits," from the auditory meatus of a little girl afflicted with otitis media purulenta chronica, had been planted.

"Since, notwithstanding a continued observation, no change in what had been sowed could be detected, I (Hagen) placed a few drops of the above-mentioned nutritious fluid upon the mass on the 21st of the month, and two days later, 23d November, I saw the formation of a copious mycelium." Hallier found on the dry, brown piece of potato, which had been sent to him, "a very beautiful patch of Mucor." But it appears to me that he had become sated with potatoes, for he does not neglect this opportunity to speak against raw as well as boiled potatoes, and denominates them "very unsuitable substrata for the cultivation of fungi." "Furthermore, the apparently most healthy potato is never entirely free from certain kinds of fungi. It is a well-known fact that the Micrococcus of the Stysanus stemonitis is almost always found in the innermost layers of the potato; it germinates quite easily, without any great preliminary swelling, and produces the Stysanus with its stachylidium—form. Even boiling does not kill the micrococcus until the process is productive of entire reduction of the potato to its ultimate cells—that is, not until we produce a genuine potato-pulp." From this time on, Hallier's interest in Hagen's "aural fungi" appears to diminish. The reports concerning the results of the cultivation of fungi upon the pieces of potato sent by the untiring Hagen, become shorter, and proclaim more distinctly the doubt, on Hallier's part, of the

genuineness of the origin of the fungi from the ear. Indeed, nothing more is said by Hallier concerning the Otomyces Hageni, and the little word " aural fungus " is used no longer!

In the seventh case Hagen had patience sufficient to permit him to wait three weeks without being able to see any change occur in some "white pieces of skin, with a lustre similar to that of mother-of-pearl," which had been removed from the auditory meatus of a type-setter, suffering from " myringitis ulcerosa circumscripta chronica," and had been placed upon a piece of potato skin. "On the 21st of November, I (Hagen) placed a few drops of the above-mentioned nutritious fluid upon the preparation, and in four days I saw the growth of quite a rich mycelium, having the lustre of silk." According to Hallier this was composed of an intermediate form of Stachylidium—Penicillium. Hallier does not neglect in this instance to say, " What I have said elsewhere concerning the substratum holds good in this case too."

In the eighth case Hagen appears willing to acquiesce in Hallier's inimical judgment concerning potatoes as a soil for the cultivation of fungi, and institutes a controlling experiment. For the latter purpose he places " whitish-yellow pieces of skin, from the ear of a patient affected with some unknown kind of disease of the ear, upon two different cultivating strata—potato-pulp and cork—and thereby he obtains two different kinds of fungi!

" On the 9th day of the same month I found, sprouting from the piece of cork, a fawn-colored fungus, and upon the potato-pulp there had developed, by the 10th day of the same month, a copious white, and delicate mycelium, which had assumed, by the next day, in certain spots, a bluish, pale green color."

In Hallier's hands, however, the colors of Hagen's " aural fungi " become transposed. His description is short and obscure, as follows: " On the cork, as well as on the pieces of potato, there was a very delicate greenish (not fawn-colored) fungus, and upon the potato a brownish (not pale green) fungus, with aerial conidia, which were arranged partly in solitary, and partly in brush-like groups, so that the appearance was partly that of Penicillium and partly that of a simpler form (which ?) of fungus.

The attempts at cultivation upon this material have unfortunately very little prospect of success. After this controlling experiment we might suppose that Hagen had been induced to

see the sad results of his search for fungi! But no! He supplies us with still "further cases of fungous diseases of the ear," which furnish still more striking proof of his complete inability to institute scientific investigations in this department of knowledge.

In the ninth case (otitis media chronica, with loss of both membranæ tympani, after measles) Hagen returns to the "pieces of potato and the nutritious fluid," in order to raise a delicate white mycelial web from what appeared to be a white diphtheritic membrane from the auditory meatus, which mycelial growth, on the next day, showed a bluish-green, or partly black, coloration." Hallier pronounced the "black" fungus to be a Stachylidium, with this remark: "This form of fungus is not unfrequently found upon potatoes."

Hallier says nothing, however, upon the "bluish-green fungus." In all probability it was a Penicillium which also arose from the potato, as in case VII.

In the tenth case Hagen obtained, by means of the "pieces of potato" and the "nutritious fluid," four different kinds of "aural fungi"—Stachylidium (Aerostalagmus), Penicillium, Tricothecium roseum, and Aspergillus.

In this case Hallier makes the following important statement:—"On account of the great diversity of the forms occurring in this case, I (Hallier) consider it doubtful whether they sprang from the original mycelium taken from the ear (which Hagen had not determined by any preliminary examination), and therefore I do not contribute any drawings of them."

In the eleventh case Hagen obtains, by means of two pieces of potato, two fungi from the same ear, one of which Hallier considered similar to a Tilletia, and pronounced the other a Stysanus stemonitis. Concerning the latter, Hallier says: "The Stysanus of the second potato is, in all probability, not developed from the mycelium removed from the ear, but from fungous elements already present in the potato."

In the twelfth case Hagen makes, to a certain extent, an advance. He renounces the "nutritious fluid," and places the pieces of potato in separate glass vessels, containing perforated gutta-percha stoppers, provided with a glass tube bent downwards. Subsequently he obtains, in each vessel, a different "aural fungus" upon the piece of potato—in one an Acrostalag-

mus, in the other a Torula, similar to the Torula rufescens, according to Hallier's examination, as stated by Hagen.

In the thirteenth case (last ?) Hagen reassures us with the statement that "all portions of this cultivating apparatus were previously subjected to a thorough disinfection." The small piece of cork, which has been sowed with the firm "brownish-yellow mass" removed from the ear, was covered in the course of time with a fungous growth, "which Herr Prof. Dr. Hallier recognized as a Tricothecium roseum."

Which should excite in us the more wonder : Hallier's amiable readiness to denominate an entire series of potato fungi, "Dr. Hagen's aural fungi," or the inordinate hardihood which allowed Hagen to sow over a number of "pieces of cork" "membranous lamellæ," removed from ears, the morbid history of which did not excite the least suspicion of the presence of fungi, although Hallier even had pointed out to him the unsuitability of this substratum for the cultivation of fungi ? Although among all the thirteen cases of Hagen's "fungous disease of the ear" we cannot find one which is really a well-mårked case of "fungous disease of the ear," we do find in the same "Zeitschrift für Parasitenkunde" (Bd. ii., p. 64–65) diagrams of a reliable case of Aspergillus in the ear, observed by Nölting, of Lübeck. In its ætiology, this case resembles my eleventh case (Die Myringomykosis, etc., p. 29), inasmuch as Nölting's patient had likewise placed in his right ear a geranium leaf for the cure of toothache, and subsequently manifested symptoms of myringomycosis.

The external auditory meatus was almost entirely filled with a white, membranous mass. By means of energetic syringing with warm water, a globular, softish mass was dislodged, after a number of membranous shreds had been removed from the ear. An examination of this globular mass revealed a cavity in it, covered with blackish-green fungi, as could be seen with the unaided eye. The presence of fungi was subsequently proven beyond all doubt by means of the microscope. In Hallier's note, which is appended to this account, we find these words : "This fungus is a very beautifully developed æro-conidian form of a Pyrenomycete of the old species Aspergillus." The diagrams adduced by Hallier fully prove the identity of Nölting's fungus with my Aspergillus nigricans—a circumstance which is alluded to by

Hallier himself in this connection. The growth of the fungus was not attended with otorrhœa in Nölting's case.

In this true case of fungous disease of the ear, both Nölting and Hallier directly proved the existence of a fructifying fungus in the ear, *i.e.*, they found the sporangia of a developed fungus in the pseudo-membrane removed from the ear, without resorting to any intermediate cultivation of it upon pieces of potato. This is a *conditio sine quâ non* for the establishment of a diagnosis of fungous growth in the ear! Mycelium without sporangia cannot be accepted as sufficient evidence of the presence of a myringomycosis.

Josef Gruber,* of Vienna, has frequently seen the occurrence of inflammations in the external ear as results of fungous growths, and has given a most interesting account of his observation of the growth of a fungus (Aspergillus flavescens) in the ear of a rabbit.

He found "the growth in the closest proximity to the membrana tympani, covered with a mass resembling pus, the membrana tympani destroyed, except a narrow, peripheral margin, the mucous membrane of the cavity of the tympanum slightly thickened, and a whitish deposit upon the mucous membrane, but no trace of purulent matter in the tympanic cavity. The mass already alluded to as purulent, and found in the auditory meatus, as well as the mass from the cavity of the tympanum, was examined under the microscope, and revealed the presence of a collection of Aspergillus, with extraordinarily numerous bright-yellow sporangia. These were much smaller than the sporangia of the Aspergillus nigricans, which, up to the present time, I (Gruber) had almost always found."

Gruber thinks it is very probable that the inflammation, with destruction of the membrana tympani, in the rabbit was produced by the growth of Aspergillus.

Gruber's observations agree in all important points with mine; there is, however, one exception, to which Gruber alludes in these words: "I cannot agree with Wreden in his view that only inflammation of the membrana tympani is caused by the fungi in the ear, for I have seen cases where fungous growths, such as he

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* Josef Gruber: Lehrbuch der Ohrenheilkunde, 1870, p. 316–319.

describes, have produced inflammation of the entire external auditory meatus, as well as of the membrana tympani."

This assertion rests upon a false impression. I have never made the statement that only the membrana tympani was attacked by the fungous growth. On the contrary, I have already stated in my first work upon myringomycosis (six cases in Archiv für Ohrhlk., 1867, Bd. iii. p. 17), the following: "I was able to observe the rapidity with which the injected membrana tympani gradually became covered with a white deposit, which during the next three to five days, with increase of the objective symptoms (hardness of hearing, great tinnitus and lancinating pain in the ear, with (in Cases III. and V.), excessive pain, resembling that of myringitis acutissima), assumed the appearance of a white membrane, which rapidly increased in thickness and covered the inner third of the auditory meatus. The formation of this membrane was not attended, in any of my cases, by a suppuration of the membrana tympani or auditory meatus. Therefore, according to my opinion, the occurrence of the growth of Aspergillus in the ear must be considered a special idiopathic disease of that part of the body; and as in eight of my cases I was able to detect the primary disease of the membrana tympani besides the usual subjective and objective symptoms of the occurrence of a myringitis, I consequently believe the most suitable designation for this new form of disease would be mycomyringitis, or myringitis parasitica."

I have made the same statement at various places in my monograph on myringomycosis (p. 38, bottom, p. 46, top), and I have also, at page 47, made this statement: "The prognosis in mycomyringitis is, in general, favorable, for usually the fungous growth is confined to the layer of epidermis of the membrana tympani and the adjacent parts of auditory meatus, and after the destruction of the fungus there is no permanent disturbance of the functions of the ear.

"Yet, in some exceptional cases, the membrana tympani, in consequence of excessive disease and neglect (Case IX.) may be perforated, and the parasite may ultimately grow upon the mucous membrane of the cavity of the tympanum."

In conclusion, we may say on this point that, in my history of cases I constantly allude to the liability of the auditory mea-

tus to be affected in myringomycosis, and I have drawn special attention to the "glove-finger" form of pseudo-membranous tube-cast of the auditory meatus and membrana tympani.

Gruber's deductions from his investigations on this topic display not only great precision and clearness, but also the copiousness of his experience, and therefore deserve our marked consideration. No other investigator, so far as I am aware, has assumed a position so entirely free from prejudice respecting the pathogenetic significance of aural fungi as Josef Gruber. His opinions, therefore, command our fullest attention. Gruber may, indeed, with certainty assume—

"1. That the fungi usually found in these cases are such as may be classified as Aspergillus nigricans and Aspergillus flavescens, but that other kinds of fungi may also find a place of growth in the ear. (Graphium penicilloides has been found here by Hassenstein and Hallier.)

"2. Fungi are usually found in the deepest portions of the auditory meatus, and upon the membrana tympani, in the form of pseudo-membranes, which, when subjected to microscopic investigation, are found to be composed of fungi chiefly, with more or less altered epithelium and the objects usually found in the auditory meatus, as cerumen, hairs, etc., and if inflammatory processes have been or are present, we shall also find in this membranous formation the various constituents of the exudation produced by the inflammation.

"3. That the sporangia are usually found in the structures which lie nearest to the membrana tympani.

"4. That fungi may be present in the auditory meatus for a long time without producing disease.

"5. That frequently the otitis externa circumscripta, as well as the diffuse form, is caused by fungous growths, and that the Aspergillus is found in the lower animals and may be productive of inflammation in the auditory meatus in them.

"6. That the membrana tympani is frequently injured by the fungous growth."

I would like, however, to add to these conclusions made by Gruber the following remarks :

I. The Aspergillus, with its different varieties and fructification-

forms, must be designated as the specific aural fungus, as I have already shown in my former writings on this subject.

In 74 cases of myringomycosis, which have come under my observation, I found Aspergillus nigricans 49 times, and Aspergillus flavescens 24 times. In one case only I discovered an Otomyces purpureus with utricles, and the ascomycete form of Aspergillus, on which account it might be called the Aspergillus ascophorus purpureus.

We see, therefore, that the Aspergillus nigricans occurs twice as often as the Aspergillus flavescens, although in my first 14 cases I had observed the latter more frequently than the former. ("*Die Myringomykosis*," p. 47.)

If, however, Gruber says "that other varieties of fungi may be found in the ear," and bases his assertions on the Graphium penicilloides of Hassenstein and Hallier, I must, on the other hand, state that, so far as my knowledge goes, both Hassentein's and Hallier's "aural fungi" must really be called "cork-and-potato fungi," since they were not found already developed in the ear, but were obtained by a variety of experiments in artificial culture.

In all my cases which have manifested both objective and subjective symptoms of "myringomycosis," I have found, so far, only various kinds of Aspergillus—and the same fact is demonstrated by the observations of others in Europe and America. In all of my 74 cases I have not even in one instance found Penicillium, which is the usual attendant of Aspergillus elsewhere, a circumstance to which I have already alluded in my earlier writings.

Only Clarence J. Blake (see above) describes one case, in which the membrana tympani and the inner end of the auditory meatus were overgrown with Aspergillus nigricans, while the yellowish white covering of the outer end of the auditory meatus was composed of a bastard form of Aspergillus with Penicillium. Since, however, the diagram which accompanies this article by no means displays such a copulation form, but rather portrays an Aspergillus—sporangium, covered with sterigmata, from which the spores have already fallen, and since a reliable botanical description of the Penicillium is wanting, Blake's case cannot yet be accepted as an exception to the rule.*

* Of course Hagen's Penicillium is out of the question, for it grew upon "pieces of apple and potato."

If, for reasons already given, we exclude Hallier's, that is, the "Hassenstein-Hagen aural fungi," we still have in more than 100 cases of fungous growths in the ear, three cases in which fungi other than Aspergillus have been found. The first of such cases ("*Die Myringomykosis*," p. 44), was described by Von Troeltsch, having occurred in the ear of a patient in whom, upon a very small spot on the superior wall of the osseous auditory meatus, near the membrana tympani, a small fungous patch of the Ascophora elegans and the Ascophora mucedo (according to Prof. Schenk's decision) was found.

This small fungous growth had not produced any symptoms of disease, and, since it was confined to a small spot on the wall of the auditory meatus, it cannot be classified among the cases of myringomycosis. The second case is reported by Steudener from the practice of H. Schwartze. This was a species of Tricothecium. But as there is no description of the symptoms produced by it, we are unable to decide whether this case should be classified with other cases of myringomycosis, or whether, like Von Troeltsch's case, it should be denominated a circumscribed case of mycosis of the auditory meatus.

Finally, we find a third case in an article by Böke, tabulated as Mucor mucedo s. fuscus. Since, however, the mycological diagnosis was neither made nor corroborated by a specialist in mycology, and as there is a total want of description and drawing of this fungus, the scientific worth of this case remains at present undecided.

II. In myringomycosis the false membrane is developed only on the adjacent parts of the auditory meatus, and only in very rare cases involves the inner third of the same. We find that this false membrane is usually moulded into a cast of the membrana tympani and the acute angle formed between the latter and the inferior wall of the auditory meatus. The formation of this false membrane is unattended by any otorrhœa of a purulent nature, as is shown not only by my experience, but by that of other authors (F. E. Weber, Orne Green, St. John Roosa, Clarence J. Blake, Bezold, J. Böke, A. Lucæ, Nölting, *et al.*).

Only Hassenstein and Hagen describe "fungous diseases of the ear" with purulent discharge from the ear. How far we are forced to doubt the genuineness of these fungous diseases of

Hassenstein, Hagen, and Hallier has been already frequently stated.

That a slight serous discharge from the ear in myringomycosis is often seen, I have already stated in my monograph (p. 38–39.), and the same fact is also noticed by other writers. But the fungous growth *never* causes a real purulent otorrhœa. Only in very rare cases (3 times in 74 cases) do we find fungous growths upon the membrana tympani, in cases of chronic perforative inflammation of the middle ear, and only after the suppuration of the membrana tympani has ceased, and a slight mucous discharge from the lining membrane of the cavity of the tympanum continues. So far I have never known a single case of otitis media purulenta in which, during a profuse purulent discharge, a fungous growth has been developed.

An existing purulent inflammation of the ear, as a rule, excludes the possibility of fungous growths ; but an ear in which such an inflammation has run its course may evince a certain predisposition towards the formation of fungous growths.

III. The surface of the false membrane turned towards the cavity of the auditory meatus usually looks white, like a piece of fat pork, while the surface turned towards the membrana tympani contains the ripe sporangia in the form of bright yellow (A. flavescens) or black (A. nigricans) spots, arranged, very often, in circles. In one solitary case, in which I found the highest development of the fungus, viz.: the ascomycete form, the entire false membrane possessed in all its layers a beautiful purplish-red color.

IV. I have never found that fungi could be a long time in the auditory meatus without producing morbid changes, nor do we find any proof in literature that such is not the case. It is true that Von Troeltsch found a case of circumscribed mycosis of the auditory meatus which had produced no subjective symptoms of disease ; but he adds that after he had removed the mass of fungus from the "solitary little spot" on the superior wall of the osseous auditory meatus, that he discovered "a small, slightly purulent point." In Bezold's case of myringomycosis (see above), although there were no symptoms of irritation of the fibres of the trigeminus, the fungous growth increased the hardness of hearing and tinnitus aurium, and produced moderate tumefaction and hyperæmia of the cutis of the membrana tympani.

In twelve of my seventy-four cases I found that the fungous growth had produced neither pain nor itching in the ear, and in four cases neither pain nor tinnitus was produced. But in all of these comparatively rare cases of myringomycosis I always found, at least, hardness of hearing and objective symptoms of irritation. It is hardly likely that a growth may extend over the entire membrana tympani, in the form of a more or less thick pseudo-membrane, without attracting attention, and it is not fair to call such a growth "a meaningless and unimportant accident."

On the other hand, however, I am willing to admit, *à priori*, that a small circumscribed fungous formation may occur at certain points of the auditory meatus, without producing any subjective signs of irritation of the sensory nerves of the meatus auditorius and of the acoustic nerve.

If Gruber classifies subjective manifestations of disease under the head of "morbid changes," I am willing to concede a possibility of their absence in a circumscribed mycosis of the auditory meatus, although I have never observed such a case. But a myringomycosis without subjective symptoms is not supposable even *à priori*. It must at least produce a diminution of the hearing.

V. I have often observed in the course of myringomycosis an otitis externa circumscripta, as well as an otitis externa diffusa, but a parasitic inflammation of the auditory meatus I have never seen without a simultaneous or an immediately preceding mycosis of the membrana tympani; but I do not mean by this statement to deny the possibility of such an inflammation of the meatus without preliminary mycosis of the membrana tympani. On the contrary, I think we may suppose, *à priori*, that it is very probable that a mycosis of the auditory meatus may produce such results. The exact scientific proof, however, of such a fact has not been given by any author.

VI. It must now be considered a fact, established by observations in Europe and America, that the membrana tympani is often injured by fungous growths.

Usually these growths are confined to the cutis of the membrana tympani; but in very rare cases (Politzer's case) the fungus may invade the fibrous layer of the membrana tympani, producing in such a case much less destruction, *i.e.*, less perforation

of the membrana tympani, by reactive inflammation, and finally take root in the mucous membrane of the cavity of the tympanum. (See my case No. IX., and Gruber's observation in the ear of a rabbit.) Since aural fungi grow in the living tissue of the ear of man and the lower animals, I have, from the outset, denominated myringomycosis, in all of my early works, a parasitic disease of the ear. This view is in a measure controverted by the circumstance that all the fungi in the ear which have been examined by mycologists in general, but more especially, of late, by De Barry,* have not been considered genuine clinging parasites, such as are usually found on living animals and plants, but have been pronounced mouldy saprophytes, that is, fungi which inhabit only dead organic matter.

This difference is of the greatest importance, for the parasites were considered the immediate producers of the disease, and which, according to their species, excited specific symptoms of disease upon plants and animals, whereas in the saprophytes, we see only secondary growths upon dead animal and vegetable matter, the more rapid destruction of which they favor.

It is indeed true that in quite a large number of cases various species of Aspergillus have been found *upon* living animals, but always in diseased and partially decomposed organs (principally the lungs), in which, of course, the necrotic tissue supplies the necessary nidus for the fungi. The fungous growths must, in such a case, be regarded as secondary manifestations, and of no real importance, and they have been thus characterized by various authors, especially by Virchow.†

Steudener (l. c., p. 107) has endeavored lately, in harmony with De Barry, to elaborate this theory of fungous growth in the ear, and has given the following reasons :

" We must therefore suppose that aural fungi will be developed on any dead organic substance, which accumulates in the auditory meatus or upon the membrana tympani, and that finally, when they are thus developed upon the membrana tympani, they

* De Barry : "Morphologie und Physiologie der Pilze." Hoffmeister's "Handbuch d. physiol. Botanik.," 1866, Bd. ii., Abth. i., p. 225.

† Virchow : Beiträge zur Lehre von den beim Menschen vorkommenden pflanzlichen Parasiten (Virchow's Archiv, Bd. x., Heft 4, p. 557 f.).

will act like foreign bodies and excite an inflammation in this delicate structure.

In explaining these inflammatory manifestations, we must perhaps take into consideration that these paraphytes excite in the structure where they locate themselves very considerable chemical decomposition, the results of which are water, carbonic acid, ammonia, and simpler organic compositions than the original ones. (De Barry, l. c., p. 231.) I therefore consider it not impossible that the structures formed by this process of decomposition irritate the membrana tympani and produce those inflammatory symptoms all the more easily, since the membrana tympani, on account of its extraordinarily thin layer of epidermis, is especially sensitive (?) to such influences.

But this fact cannot be established until an opportunity is offered to examine anatomically a membrana tympani covered with such a growth of fungus, and in which the microscope reveals the fact that the fungous elements have penetrated into the tissue of the membrana tympani. Such a case would place the parasitic nature of this affection beyond all doubt."

But such cases have been observed both by Politzer and Gruber, and therefore, even in the eyes of the Instructor in Pathological Anatomy, of Halle, the parasitic nature of myringomycosis is proven beyond all doubt! This doubt might have been avoided by the above-named author, as well as my criticism and correction, if he had instituted his own investigations concerning the growth of fungi in the ear, instead of contenting himself with the microscopic examination of two false membranes obtained from the aural practice of H. Schwartze. He would have convinced himself, *ad oculos*, that aural fungi do not "develop in any dead organic matter which accumulates in the auditory meatus and upon the membrana tympani," etc., but that they grow into the structure of the membrana tympani, and cannot be removed from it until, through reactive inflammation, the layers of the cutis which have been penetrated by the fungous growth have been detached. An attentive reader of my monograph (p. 38 and 46–47) must also have gleaned the same fact.

For the characteristic prodromes which I have described there, viz.: the injection of the vessels of the malleus, the gradual growth of the fungi (from the white early growth on the redden-

ed membrana tympani to the thick, sac-like false membrane which entirely hides it), the detachment of the pseudo-membrane from the membrana tympani (the occurrence of pain), the conditions of the bared membrana tympani (exposed, inflamed corium), and lastly, the entire meaning of the sentence (p. 45) : " In any event the mechanical action is neither the essential nor the only one, as, for example, in cases of ceruminal accumulations or foreign bodies in the ear," all these, I say, might have taught Steudener the true nature of the case. The numerous recent observations upon fungous growths in the ear which I have made in the last five years, *i.e.*, since the publication of my monograph on " Myringomycosis aspergillina " (1868), I have not minutely described here, since they could only serve as new illustrations of my former views on the nature of myringomycosis, as well as the description of the disease I have already given. Neither have I anything new to add respecting the prognosis and treatment of myringomycosis ; but what I have already said I firmly adhere to.* In regard to the diagnosis, I must distinctly state that, in order to establish it beyond all doubt, it is absolutely necessary to prove the existence of fructiferous hyphens in the ear.

Those cases in which only fractional portions of mycelium, without any organs of fructification, are found in the ear, cannot be called fungous diseases of the ear, even when it happens that, in the course of time, it is possible to demonstrate that by their aid the most luxuriant patches of fungi have been raised on " pieces of potato," etc.

Attention must also be given to the differential diagnosis between myringomycosis and primary circumscribed mycosis of the auditory meatus, in which connection we must bear in mind that in myringomycosis the fungus may spread itself, as is shown by experience, upon the auditory meatus as well as the cavity of the tympanum.

In respect to the ætiology, we may state that of 74 cases 51 were males and 23 females, and their ages were as follows :

10–20 years	7	40–50 years	14
20–30 "	20	50–60 "	6
30–40 "	24	60–70 "	3

* My former statement, that Aspergillus flavescens occurs more frequently in the ear than A. nigricans, I have already corrected, since exactly the reverse has been proven from a number of observations.

The youngest patient was 15 years old, the oldest was 69 years old. I have never found myringomycosis in children, and rarely in the very aged. It appears that this disease occurs twice as often (44 cases) between 20 and 40 as between 40 and 60 (20 cases); 18 cases of the 74 were affected in both ears, and 52 were affected in one ear only, viz.: 27 right and 25 left. Of the aforesaid 18 cases of ambilateral myringomycosis 6 came to me with the disease already on both sides; but the other 12 came first as patients suffering from disease in one ear, and not until two to four weeks had elapsed were the same fungi found in the other ear. I have never yet found in the same individual Aspergillus flavescens in one ear and A. nigricans in the other, but always the same form of fungus in both ears. Without exception, I have always found only one species of fungus, and all other reliable authors make the same statement. Only Blake states that in a case of relapse of myringomycosis he found Aspergillus nigricans on the membrana tympani and the inner portion of the auditory meatus; but in the region of the mouth of the auditory meatus he found a bastard form of Aspergillus and Penicillium. I have already demonstrated above how this assertion is contradicted by the diagram which accompanies it. When, however, we find that Hagen and Hassenstein endeavor to show that they have found two or three kinds of fungi in the same ear, because the cultivation of the aural secretion which they instituted on corks, potatoes, etc., gave as many different results, we can only call it a most mournful error, which was calculated to delude the ignorant into the idea that the ear plays the part of an inexhaustible hot-bed for the production of fungi, to confuse the already correct views of the growth of fungi in the ear, and by that means to bring the entire theory of myringomycosis into discredit. This danger was all the greater because Hagen carried on his fungous investigation in the ear under the ægis of Prof. E. Hallier, a well-known mycologist, and therefore must have greatly impressed all aurists who were but slightly acquainted with the secrets of the humble world of fungi. The following conclusions are based on the foregoing analysis of observations made by many other authors as well as myself:

1. Myringomycosis is an independent parasitic disease of the ear.

2. The Aspergillus, with its different forms of fructification and hybridism, must be denominated the specific aural fungus.

3. The ascomycete form (*i.e.*, the form with utricular fruit) of the aural Aspergillus has been found.

A CASE OF MYRINGOMYCOSIS ASPERGILLINA

ILLUSTRATIVE OF THE TYPICAL FEATURES OF THAT DISEASE MENTIONED IN THE FOREGOING PAPER.

By CHARLES H. BURNETT, M.D.,

Aural Surgeon to the Presbyterian Hospital in Philadelphia, and Surgeon-in-Charge of the Philadelphia Infirmary for Diseases of the Ear.

THIS case of fungous disease occurred in October, 1873, in the left ear of a female 40 years of age.

The patient was under treatment for so-called chronic catarrh of the middle ear, on both sides, complicated by ozæna. She stated that for more than a year she had been liable to sudden attacks of acute pain in the left ear, which lasted for a day or two, with augmented hardness of hearing, and then suddenly ceased, with a slight watery discharge from the meatus of the affected ear. The hearing was never permanently diminished.

At the time of this statement, she was free from pain, and I found the meatus and membrana tympani in the condition usually seen in an ordinary case of so-called chronic catarrh of the middle ear.

Within *ten days* from that time, she came to me stating that she had had, two days before, an attack of the pain already described, and that there was still a little discharge from the ear.

I examined the ear, and found the inner portion of the osseous auditory meatus and the membrana tympani covered with a false membrane resembling wet paper. I instantly inferred the presence of a fungus, and removed the false membrane very easily by means of a pair of curved forceps.

The removal caused no pain, nor were the parts beneath the false membrane very red and sensitive.

There was a slight serous discharge from the meatus, a drop of which I examined immediately, upon a clean slide under the microscope, and found that it contained no pus, but myriads of brownish yellow spores of the Aspergillus flavescens and vibriones.

The tube cast into which the mycelial false membrane had been moulded was formed chiefly of thalli, and upon its surface were free spores and tufts of aerial fructification of the Aspergillus flavescens.

Throughout the membrane thus formed were solitary epithelial scales.

The hyphens, or fruit-stalks, were not septate, and their large, bulbous

ends, from which the spores arise, were of a beautiful golden yellow color and resembled in their general shape and outline the ordinary "onion-top."

In reference to the ætiology I would state that the patient had resided for some time in a damp house, the cellar of which was "covered with mould," but previous to that time she had never suffered from any fungous disease of the ear, as far as she knows.

The chronic disease of the ear may have induced a predisposition to the development of fungi, the possibility of which is stated in the foregoing paper of Wreden.

The treatment consisted in several instillations of a solution of nitrate of silver (100 gr.—f. ℥ i.), which I applied, while the patient used at home instillations of alcohol (90 per cent.) six to seven times daily, with frequent syringing of the ear with warm water.

All symptoms of the fungous disease of the ear disappeared under this treatment; but I cannot state whether there has been any return of the disease or not, as I have not seen the patient. The hearing, which was not normal at the time of the formation of the false membrane in the ear, was found to have been unaltered by the disease, for it remained the same as before the attack.

The hearing was impaired only from the time the pain began until the false membrane was removed.

Had I attempted to remove the false membrane during the pain, I might have found that its removal was difficult to myself as well as painful to the patient, as Wreden did in his cases. In my case, however, the cessation of pain, the easy removal of the false membrane, and the absence of redness of the subjacent parts, seem to indicate that Nature had already commenced a process of detachment and removal of the fungous cast of the parts of the ear which had been attacked by the Aspergillus.

This, I think, may account for the difference between Wreden's experience in the removal of the false membrane and that in the case I have just described.

The presence of vibriones might have been inferred *à priori*, but I do not know that they have been seen in fluids removed directly from the human ear. It will be observed that the species of Aspergillus found in this case is that shown by Wreden to be the most usual form of aural fungus, and that nearly all the attendant symptoms were those which he has shown to be typical of a true case of myringomycosis aspergillina.

A CASE OF PEARLY TUMOR (CHOLESTEATOMA) IN BOTH EARS.

By CHARLES J. KIPP, M.D., of Newark, N. J.

According to Lucæ,* pearly tumors in the ears are by no means of unfrequent occurrence. Whilst this statement doubtless holds good for Germany, it does not seem to apply to America, if we may judge from the published statistical reports of various large institutions for the treatment of ear diseases. An examination of the Report of the New York Eye and Ear Infirmary for 1872 (2,397 ear cases); of the Report of the Massachusetts Charitable Eye and Ear Infirmary for 1872 (1,652 ear cases); of the Report of the Manhattan Eye and Ear Hospital for 1871 (440 ear cases); and of the Reports of New York Ophthalmic and Aural Institute for the years 1869, 1870, 1871, 1872, and 1873 (3,299 ear cases), show that amongst the 7,788 cases of ear disease treated at these institutions, not a single case of pearly tumor of the ear was observed. Dr. Laurence Turnbull, in his Clinical Manual of the Diseases of the Ear, makes no mention at all of this disease, and Dr. Roosa, in his Practical Treatise, merely states that pearly tumors have been found in the cavity of the tympanum, but does not say that he has met with this affection in his own practice. The comparative rarity of pearly tumor in the ear in this country being apparent from the above statements, an apology for publishing the following case of this disease seems unnecessary:

J. C. C., æt. 27, consulted me about fourteen months ago on account of progressive deafness of both ears. His history was as follows: He had scarlatina when six years old, which was followed by a discharge from both ears. The discharge continued until he was twelve years old, although it would occasionally stop for a few months, and then return after a severe earache. Since then his ears have been quite dry. During his sixteenth year he noticed a gradual increase of deafness, and consulted a physician with reference to it, who removed large white masses

* Archiv f. Ohrenheilkunde, N. F., I. Bd., 4 Heft, S. 255.

from both ears. This operation was followed by a considerable improvement in his hearing. The improvement, however, continued but a short time. For the last year he has suffered from persistent severe pain in back of head, almost constant vertigo, and sickness of stomach. His family physician believed these symptoms to be due to malarial fever, and treated them accordingly, without, however, mitigating them in the slightest degree. During the last year he has had also, at times, more or less pain in his ears.

On examination I found that he could hear the tick of a watch of five feet normal hearing distance only when firmly pressed against either auricle. In both ears the external meatus was completely filled with a brownish-black mass, which I at first supposed to be inspissated cerumen. After softening these masses by repeated instillations of a warm solution of carbonate of soda, each ear was syringed for about an hour, without, however, bringing away more than the outermost layers of the collections. On the following day the same operation was repeated with about the same success. As the tumors now presented a whitish pearly surface, their true character was recognized, and their removal attempted with the aid of a spatula, Daviel's spoon, and a pair of forceps. After several hours of patient digging and picking, the tumors were extracted piecemeal, and without causing the patient much pain. The operation was immediately followed by a very decided improvement in hearing. In the left ear, the bony portion of the external canal was found to be greatly increased in calibre ; the walls were carious, and in some parts covered by granulations. The lower portion of the sulcus tympanum presented itself as a ridge about one mm. in height. The drum-head and the ossicles were wanting. The mucous membrane over the promontory was granular in appearance. Air could readily be forced through the Eustachian tube into the tympanum. The external meatus of the right ear was found in the same condition as that of the left ear. The membrana tympani was present, was very opaque, and evidently much thickened. In its upper and posterior quadrant was a well-marked cicatrix. The handle and short process of the malleus could not be recognized. The fragments of the tumors were of a decidedly lamellated structure, and examined microscopically, they were found to be composed chiefly of flattened epithelial cells, in some of which a nucleus could be seen ; abundant crystals of cholesterine and fatty acids, and minute shining bodies, some of a round, others of irregular form. The patient was so well pleased with the improvement in his hearing that he did not present himself again till about three months after the removal of the tumors. He was now almost as deaf as before the operation, and,

in addition, had a profuse offensive discharge from his left ear. After the removal of the pus, the walls of both external canals were seen to be lined by a thick, white, shining membrane, and from the deepest portion of the posterior wall of the left grew a large mass of granulations. The granulations were removed with a Wilde's snare, and the membranes with a Daviel's spoon and a pair of forceps. Under the microscope the membranes presented precisely the same appearance as the tumors previously removed.

The appearance of the walls of the external meatus, and of the lining membrane of the tympanum of the left ear, and of the external canal and drum-head of the left, was very much the same as that found three months before. A decided improvement in hearing followed the operation. The granulations were thoroughly touched with a crayon of nitrate of silver, and frequent cleansing with warm water, and instillations of a weak solution of sulphate of copper were ordered. During the first six months following this last operation the patient was seen at short intervals, and each time he presented himself the external canals contained more or less of the same white material. The granulations covering the carious bone gradually disappeared under the repeated applications of the nitrate of silver, and since their destruction the white membranes have not been reproduced. At present the ears are entirely dry, and no carious bone can be detected in either ear. The drum-head of the right ear remains very opaque and somewhat sunken. The lining membrane of the tympanic cavity of the left ear is smooth and of a pale color. The patient's hearing is so greatly improved that he hears ordinary conversation with ease with either ear, and his general health is excellent.

With regard to the origin of the tumor found in the right ear, there can, I think, be no difference of opinion. The drum-head, although greatly changed, was present, and the tumor must therefore have originated in the place where it was found—the external meatus. The tumor found in the left ear occupied not only the external canal, but also the cavity of the tympanum; and may have had its starting-point in either or both. I am, however, inclined to the opinion that it took its origin from the external meatus, and this opinion is based on the fact that, after the removal of the tumor, a substance identical with it was repeatedly found covering the granulations in the external canal, whilst on the granular mucous membrane of the tympanum no trace of this substance was observed during the whole time the patient was under observation.

OTOLOGICAL REVIEW.

By C. J. BLAKE, of Boston.

Anton v. Tröltsch. Lehrbuch der Ohrenheilkunde mit Einschluss der Anatomie des Ohres. Fünfte verbesserte und vielfach umgearbeitete Auflage. Leipzig, Verlag von F. C. W. Vogel, 1873.

A. D. Williams, M.D., St. Louis. Diseases of the Ear. Robert Clarke & Co., Cincinnati, 1873.

D. B. St. John Roosa, M.D., New York. Treatise on Diseases of the Ear. William Wood & Co., New York.

C. H. Burnett, M.D., Philadelphia. The External Ear a Synthetic Resonator. *Philadelphia Medical Times*, October 4th, 1873.

Prof. Wilhelm Wundt, Heidelberg. Grundzüge der Physiologischen Psychologie. Leipzig, W. Engelmann, 1873.

Dr. C. Hasse. Anatomische Studien. Viertes heft. W. Engelmann, Leipzig, 1873.

Boettcher, Hasse. Die Lymphbahnen des inneren Ohres der Wirbelthiere. *Archiv für Ohrenheilkunde*, January 13, 1874.

E. Zuckerkandl. Zur Anatomie und Physiologie der Tuba Eustachiana. *Monatsch. für Ohrenheilk.*, December, 1873.

Cyon. Ueber die Function der halbcirkelförmigen Canäle. *Archiv für Physiologie von Pflüger*, December, 1873.

Hughlings Jackson. Auditory Vertigo. *London Lancet*, September 6, 1873.

August Lucae. Beiträge zur Kenntniss der Perlgeschwulst des Felsenbeins. *Arch. für Ohrenh.*, *Neue Folge*, i. p. 255, etc.

H. Wendt. Desquamative Entzündung des Mittelohrs. *Archiv für Heilkunde*, Band 14, p. 427, 1873.

J. Orne Green. Cases Illustrative of Mastoid Inflammation. *Boston Medical and Surgical Journal*, January, 1874.

Jos. Gruber. Case of Facial Paralysis, disappearing after Paracentesis of the Drum. *Berichte der Wiener Acad. der Wiss.*, 1873.

Notwithstanding the author's endeavor at condensation and the substitution of a smaller form of type than that employed in printing former editions, the last edition of V. Tröltsch's Lehrbuch der Ohrenheilkunde reaches 542 closely printed pages. Certain additions necessitated by the advance in Otology, and especially the elaboration of such subjects as

the chronic catarrh of the middle ear, and the accompanying affections of the naso-pharyngeal cavity, paracentesis of the membrana tympani, the prognosis and treatment of affections in which otorrhœa is a symptom, and finally the consideration of the diagnostic indications of subjective symptoms, have considerably enlarged the work and proportionately increased its value.

Chapter XVIII., comprising twenty-four pages, as compared with the treatment of the same subject in the former edition, gives a much more detailed account of the possible changes occurring in chronic catarrh of the middle ear, as observable on examination of the membrana tympani, as also of the anatomical and physical conditions accompanying closure of the Eustachian tube, and a careful analysis of the symptoms obtained by catheterization, and of their value in diagnosis and prognosis. The following chapter, also of twenty-four pages, on chronic catarrh of the naso-pharyngeal cavity, is very much more elaborate than that of any former edition. In addition to a fuller description of the anatomy of the parts under consideration, and of the method of examination by means of the rhinoscope, especial stress is laid upon the tactile examination of the naso-pharyngeal space, as advised and practised by Meyer, of Copenhagen. By this means not only is a means of confirming a rhinoscopic observation obtained, but it is often possible to determine much more accurately the origin of a foreign growth. The first examination should always be a short, if even a superficial one, but the parts soon become accustomed to the introduction of the finger. Considerable, and, for the uses of the aural surgeon, deserved attention is directed to the examination of the nasal passages.

Chapters XXII., XXIV., and XXV. are devoted to acute and chronic purulent inflammation of the middle ear, with the changes and diagnostic appearances of the meatus, membrana tympani, and pharynx, together with the complications of these affections. The author adheres to his former opinion concerning cholesteatom as the result of a purulent process, and not as itself a morbid growth, and supports his views by further observations. A larger space is devoted to the microscopic appearances of polypoid growths; and in their treatment, though the galvano-caustic is mentioned, it is recommended only for the removal of the firmer fibrous growths.

Subjective noises, which are treated of in Chapter XXIX., are classed in two principal divisions; those resulting from vascular circulation, and those symptomatic of irritation of the auditory nerve. The chapter following treats of the application of electricity, with a short résumé of later observations in this field, and the volume concludes with directions

for the examination of patients and the post-mortem examination of the ear. The publisher's part of the work compares very favorably with that of former editions.

Dr. A. D. Williams, of St. Louis, contributes a handsome volume of 284 pages, entitled *Diseases of the Ear, including the necessary Anatomy of the Organ.* The pages treating of anatomy are illustrated by wood-cuts, copied from standard works on anatomy, and are distributed through the book, prefacing the description of the diseases of the parts described. The book is principally clinical in character, the author giving a résumé of the opinions of foreign and American writers upon the various diseases of the ear, supplemented by his own experience and method of treatment, thus giving the reader a fair idea of the conclusions at which the author has arrived from his own observation. Considered as a whole, and as a hand-book for the general profession, Dr. Williams's volume compares very favorably with most of the treatises which have been published lately in England.

Dr. D. B. St. John Roosa, whose translation of Tröltsch has long been the standard American text-book, has published a handsome volume of 520 pages, entitled "*Treatise on Diseases of the Ear*," which, while giving evidence of the author's own work in the field of otology, merits the remark made by a German reviewer of the text-book of V. Tröltsch, "that the author has given just and impartial credit to the labors of his colleagues." The general arrangement of the work is such as to distribute the chapters on descriptive anatomy so that they may immediately precede the chapters on pathology, symptomatology, and treatment of the diseases of the external, middle, and internal ear, an arrangement which is of convenience for purposes of reference, and which perhaps best answers the requirements of the student. An introduction of 35 pages gives a sketch of the progress of otology, which is divided under the headings anatomy and aural therapeutics, and embraces mention of the more noted observers from the time of Hippocrates to the present decade: the notes under the various dates are of necessity condensed, but present matter of interest to the otological bibliophile. Seventy-eight of the remaining 485 pages are devoted to the anatomy of the external, middle, and internal ear, and are illustrated by 46 wood-cuts, comprising a judicious selection, principally from the works of Henle and Rüdinger. While a more minute description of the microscopic anatomy of the ear does not come properly within the scope of a general text-book, the wants of the student would seem to have been sufficiently met in the anatomical portion of Dr. Roosa's work, serving as it does as an introduction to the surgical portion, which is to serve for the study and reference of the practi-

tioner. Chapter III., of thirty-four pages, gives the methods employed in the examination of aural patients, and Chapters IV. to VIII., comprising seventy-eight pages, treat of the diseases of the external ear and their treatment, and conclude Part I. of the work. The division made at large into Malformations, Tumors, Malignant Disease, Injuries, and Eczema, is further subdivided in the subject-matter which pertains to the auricle, and the affections of the auditory canal are divided into diffuse and circumscribed inflammation, vegetable fungous growths, inspissated cerumen, eczema, foreign bodies, polypi, exostoses and hyperostoses, syphilitic condylomata, and ulcers. In Part II., following the anatomy of the middle ear, the arrangement of the subject of diseases of the middle ear is as follows: Chapter X. treats of injuries of the membrana tympani, including those from various causes, and the report of the unique case of Dr. Weir, of fracture of the manubrium mallei. Chapters XI. to XVII., inclusive, comprise acute and subacute catarrhal inflammation of the middle ear, chronic non-suppurative inflammation—divided into two forms, catarrhal and proliferous—acute and chronic suppurative inflammation and their consequences, polypi, exostoses, mastoid disease, caries and necrosis, cerebral abscess, pyæmia, and paralysis. In addition to the usual treatment of the subjects included in the above headings, and covering two hundred and twenty-two pages, the author gives particularly his own observations with regard to the use of the nasal douche, and a table of analysis of reported cases of injury to the ear from its use. The object and results of Dr. Roosa's investigation of this subject are so well known as to render a reviewer's notice superfluous.

Mastoid disease, with its concomitants caries and necrosis, is treated of at length, and with a thoroughness which so grave a subject demands; and Part II. concludes with an instructive table of forty cases of meningitis, cerebral abscess, and pyæmia resulting from aural disease. The remainder of the book, with the exception of twenty-three pages on anatomy, is devoted to diseases of the internal ear, the application of electricity to their diagnosis and treatment, and to deaf-mutism and the use of hearing trumpets. In addition to one hundred and ten wood-cuts in the text, is a chromo-lithographic plate of eight illustrations of diseases of the membrana tympani, from drawings made by Dr. H. P. Quincy, and a carefully compiled index of authors and of subjects, which enhances the value of the volume as a book of reference. The mechanical part of the work reflects credit upon the publishers, and its value as a text-book is found in the perusal of its pages.

Dr. C. H. Burnett makes a further contribution to the subject of the *physiological value of the auricle in a paper entitled* " *The External Ear a*

Synthetic Resonator." Dr. Burnett discovers that the region of the helix and its fossa resound to the deeper notes, the antihelix and its fossa to the intermediate notes, and that the concha resounds best to the high partial tones. Verifying experiments were made by elimination of the different divisions of the auricle, by protecting them from the impact of sound waves, with the result of diminution of perception for the corresponding tones.

The deep tones are immediately weakened or lost by placing the finger on the helix and pressing it firmly against the head. By pressure upon the antihelix the intermediate tones become weaker, and firm pressure upon the helix, antihelix, and concha will interfere with the resonance of all but the highest partial tones. The reviewer is able to confirm the observations of Dr. Burnett from the result of somewhat similar experiments made at the same time, and the object of which was to determine the acoustic value of the fossa of the helix, antihelix, and concha.

In the first volume of his "Grundzüge der Physiologischen Pyschologie," Prof. Wundt devotes eight pages to that part of the anatomy of the ear which concerns the terminations of the auditory nerve, giving a short résumé of the later investigations of Rüdinger, Waldeyer, Hasse, and Helmholtz, with five wood-cuts borrowed from these authors, followed by a chapter of eighteen pages upon acoustics, physiologically considered, presenting a condensed review of the more important and prominent points in the quality of the perception, and the relation of perception to the value of the vibration, concluding with a short review of the subject of beats in over and combination tones.

In his investigations concerning the structure of the organ of hearing in Siredon pisciformis, Hasse has endeavored to bridge over the space existing in the observations on the progressive development from lower to higher forms. The hearing apparatus in Siredon pisciformis possesses a peculiar interest, inasmuch as it presents one of the earliest forms of a sound-conducting apparatus, although the physiological value which it has may be somewhat questioned, since it is not at all clear that a large part of the perception is the result of sonorous vibrations conveyed through the bones of the head. This structure represents a higher grade of development than that in corresponding fishes, and one which is commensurate with the diminution of development of the mechanism of the jaw.

In relation to the *development of the ampullæ and semicircular canals* this work possesses a particular interest. On removing the periosteal investing membrane, the individual parts of the organ in their form and in their mutual relations are clearly distinguishable. The three ampullæ are

found in the same position as in the osseous fishes and in frogs—two in the cavum anterius, and one in the cavum posterius, the horizontal canal outwards, the sagittal inwards and rather forwards, and the frontal, distinct from the others, lying somewhat deeper. The cristæ acusticæ which show through the vertical ampullæ, extend symmetrically upon the lateral wall out of the sulcus transversus, at which the nerve, divided into two bundles, enters.

Rising above the surface of the three ampullæ are the semicircular canals, of which the horizontal is the largest.

The anterior ampullæ enter unitedly into the horizontal cylindrical utriculus. Below, and toward the median line from the two contiguous anterior ampullæ, is an ampullar-like enlargement, the recessus utriculi, on the convex outer and under side of which the nerve enters in a fan-shaped continuation, to pass on its way to the ampullæ. This wall of the recessus is thickened, and through it is seen the macula and the small rounded mass of otoliths.

Below the convex floor of the utriculus and the canalis communis of the posterior frontal ampullæ extends the greater part of the membranous organ, the rounded and slightly ovoid sacculus, its cavity nearly filled with the otolith mass. It is made up of an exceedingly delicate outer coat, easily torn, and connected with the anterior wall of the utriculus only below the commissure, and a thicker inner coat, on which the nerve is distributed in a fan-shaped termination ; as is the case in the Teliostier, this is connected with the inner wall of the utriculus, especially below the commissure. Beyond this connection the sac is wholly separate from the overlying structures, lying only in contact with them. The otolith mass is easily removable as a whole ; but is not, as in the osseous fishes, an otolith, but rather an aggregation of otoliths, as in the higher vertebrates, enclosed in a membranous otolith sac, which is entirely filled by the otolith mass, with exception of a small portion of fluid contents. On removal of the otolith mass there is revealed a longitudinal macula, and at the same time a number of openings in the sac, which are of especial significance. Below the commissure, toward the under side of the posterior end of the utriculus, is an opening of the same form as that which in the Batrachia allows the communication between the utriculus and cochlea. At the anterior edge of this opening is a smaller opening, the apertura aqueductus vestibuli. Near the posterior edge of the former opening is a semicircular elevation, the commencement of the cochlea, passing to which is seen a delicate nerve fibril, arising from the branch which supplies the posterior ampulla, this commencement of the cochlea being only an elevation of the inner wall of the sac.

At the posterior end of the sac is another semicircular elevation, to which a larger nerve passes, separate from the nerves of the sac. This is the cochlea proper, and is much more distinct from the sac than at its commencement ; on its inner wall is a circular macula acustica, and also a rounded otolith mass.

The second paper on the organ of hearing in Coluber natrix, carefully elaborated as it is, is of value to the student as an example of the construction of the ear in serpents, and may serve as a work of reference in considering this class of development, in which the membrana tympani, tympanum, and Eustachian tube are wanting, the conditions in this case corresponding with those in the Perennibranchia and Salamanders, and placing the serpents among the lowest order of reptiles. The comparative examination of the osseous, as well as of the membranous labyrinth, as given by HASSE, still further confirms this view.

The membranous labyrinth presents two anterior and one posterior ampullæ, with the semicircular canals thereto pertaining, and the canalis communis of the frontal and sagittal canals, the elongated utriculus, below and behind this the sacculus, and still deeper the cochlea, the horizontal and sagittal ampullæ lying somewhat deeper than the frontal. The horizontal canal is directed inwards and upwards, the sagittal upwards and forwards, and the frontal outwards, upwards, and backwards. The nerve branch to the vertical ampullæ is divided into two bundles in the sulcus transversus, while the branch passing to the horizontal ampullæ is single. The anterior ampullæ are supplied from the anterior branch of the acusticus, which passes to the recessus utriculi, while the posterior ampulla receives its nerve from the posterior branch, which supplies the nerves of the sacculus and cochlea.

As concerns the direction and position of the semicircular canals, the horizontal, which is the largest, curves slightly upwards and backwards, crossing over the frontal ampulla to open into the canalis communis of the frontal and sagittal canals near its termination. It enters nearly at right angles to the canalis communis, and its end is slightly widened, the foreshadowing, so to speak, of an ampulla. Between the anterior ampullæ, as it were, and as represented in the plate, the utriculus shows an ampullar enlargement, through the wall of which the fan-shaped distribution of the nerve, the macula acustica, and the otolith mass are seen. Concerning the otoliths, Hasse refers to Scarpa, who says simply that the vestibulum is filled with a massa cretacea ; and then proceeds to a further description of the sacculus and of the otolith mass, which is invested by a delicate membranous sac, with a cavity between the upper and lower ends of the wall of the sac and the otolith mass filled with fluid. On the inner wall

of the sacculus is the usual fan-shaped distribution of the nerve, and also two openings in its wall, the larger corresponding to the communication with the utriculus, and the smaller to the apertura aqueductus vestibuli. A comparison with the description of the similar openings on the preceding page of this review will show their correspondence with the same parts in the Siredon.

Below and behind these openings is the longitudinal opening of communication with the cochlea. To this opening and to the further development of the cochlea, and its relation to the sacculus, Hasse draws particular attention, as a further evidence of the low grade of the serpents in the class of reptiles, and especially of their near relationship to the Amphibia.

The third paper, upon *The Organ of Hearing of the Crocodile*, comprises seventy pages, and from a cursory examination would hardly seem to require the apology which its author makes in his introduction, that the rarity of his material did not permit so thorough an investigation as he desired. As a review of previous investigation, and as a clear exposition of the comparative structure which finds its higher development in the organ of hearing in birds, the paper demands an extended review, which will be given later.

Another important and interesting paper in the same volume is "*Die Lymphbahnen des inneren Ohres der Wirbelthiere*,"—*The Lymph Channels of the Inner Ear of Vertebrates*. Its value as a contribution to that field of comparative anatomy in which its author has so zealously and successfully labored may best be inferred from his own words: "In the vertebrates collectively is found a tube arising from the vestibule, and, with exception of the Plagiostomata, in which it passes to the upper surface of the cranium, in all animals entering the cranial cavity, and either terminating in a cul-de-sac, forming an epicerebral lymph space, or opening into that cavity. This is the ductus endolymphaticus, or aqueductus vestibuli, with the saccus endolymphaticus, which in the majority of vertebrates arises especially from the sacculus, that is, from the inferior portion of the vestibule. The perilymphatic fluid then empties itself, in fishes, by no special course, into the cranial cavity or the epicerebral space; in Plagiostomata, however, upon the cranial surface; and in the remaining vertebrates, by means of an especial arrangement, through a narrow canal, either into the epicerebral space or into a lymph-sac lying in the foramen jugulare, which passes on the one hand into a peripheral lymph-vessel, on the other returns into the epicerebral space. This canal is the canalis s. ductus perilymphaticus, with the saccus perilymphaticus, which leaves the capsule either through the foramen rotundum or through

the apertura aqueductus cochleæ, and carries the perilymph from the capsule towards the periphery." In the simplest form of development in which the organ of hearing is represented by a sac, the ductus endolymphaticus arises from the labyrinth sac in the form of a funnel-shaped tube, passes through the dura mater, to terminate between this and the brain in a blind sac, which is filled with concretions. In a higher form, in which, with exception of the horizontal semicircular canal, the various structures of the labyrinth in the higher vertebrates are represented by elevations or tubes, the pear-shaped ductus endolymphaticus is surrounded by the fibrous envelope of the organ, and passes through the apertura aqueductus vestibuli to reach the cranial cavity, its end terminating in the epicerebral space. In the Peleostier the vestibular cavity is divided into a utriculus and sacculus with the cochlea; the vestibular end of the aqueductus vestibuli lies in the region of the sacculus, and passing upward ends in a saccus endolymphaticus, which passes through the dura mater and projects into the gelatinous tissue of the epicerebral space. In the Plagiostomata, in which the development of the recessus labyrinthi is greater than in the Teliostier, the lengthened tube presses the periosteum before it through an opening at the boundary of the labyrinth capsule, and broadens under the integument into the form of a sac; this sac is also filled with concretions resembling otoliths. That the two endolymphatic spaces should be united in some forms seems probable when we consider their apposition; the cava lymphatica of the two labyrinths are certainly in connection in the Amphibia. In these animals the aqueductus vestibuli is largely developed.

In Siredon pisciformis it arises from the inner wall of the sacculus, passes into the space within the dura mater, and extends into a large sac which unites with and opens into that of the opposite side.

Calori discovered this sac to be attached to the meninges of the brain at about the middle of its under surface, the sac lying, as seen above, upon the brain, that is, below the dura mater. "At this point Hasse has discovered fine openings through which the cavity of the sac communicates with the epicerebral space between the brain and its meninges. In Siredon pisciformis, therefore, is the first instance of an open communication between this space and the cavity of the vestibule." In the Triton the two sacs are in contact, but do not communicate with each other, nor with the epicerebral space.

In Salamandra maculata the aqueductus vestibuli enlarges within the dura mater to a sac filled with a white otolith mass. A prolongation extends inwards to unite with a similar prolongation from the opposite sac in some cases, but there is no communication with the epicerebral space.

In the Batrachia the saccus endolymphaticus is still further developed, but is subject to considerable variation, in some cases communicating freely with its fellow of the opposite side, while in other cases the communication is limited to a prolongation. "A communication with the epicerebral space could not be determined."

In serpents the ductus endolymphaticus takes the form of a tube, which enters the cranial cavity at the side of the cerebellum and passes upwards along the lateral wall of the skull to terminate in a small pear-shaped sac, in contact with the sac of the opposite side, but without communicating with it or with the epicerebral space. At the point of contact the sacs are covered by the thickened dura mater.

In the tortoise the ductus, having entered the cranial cavity, appears, as in other reptiles, to be covered by the dura mater, but widens to a large sac overlying the posterior portion of the brain and meninges, and in contact with the sac of the opposite side. The saccus endolymphaticus lies therefore in the cavity between the brain and meninges, and its tube is covered by the latter and by the periosteum of the labyrinth capsule.

In the crocodile there is no communication with the epicerebral space, while in birds it is present, the upper end of the aqueductus vestibuli not being a cul-de-sac, the tube being, as it were, a continuation of the small sacculus, and opening by a tunnel-shaped enlargement into the cavum epicerebrale. In BOETTCHER'S *review of this paper*, from which a portion of the above quotations are borrowed, he refers to his own observations on the mammalia and man, especially in regard to the office of the aqueductus vestibuli, and to his investigations in the embryo. Hasse, in conclusion, lays particular stress upon the communications of the cavum perilymphaticum, and the consequent transmission of pathological processes, for the better understanding of which it is best to quote his own words:

"The cavum perilymphaticum is, on the one hand, in connection with the cavum subarachnoideale, through the foramina acustica, and indirectly with the peripheric lymph spaces, and so with the ductus and saccus perilymphaticus, and we can perceive that all changes, whether of a physical or chemical nature, which affect the liquor cerebro-spinalis, may be communicated to and affect the liquor perilymphaticus, and thus the organ of hearing and its function. Furthermore, pathological processes in the subarachnoideal space may be transferred by continuity, or by contiguity through the ductus and saccus endolymphaticus to the interior of the labyrinth, and vice versa. In the same manner changes in the chemical constitution of the cerebro-spinal fluid would necessarily induce

changes in the liquor endolymphaticus, which would have an influence in the production of subjective symptoms."

In a contribution to the *anatomy and physiology of the Eustachian tube*, Dr. Zuckerkandl supplements the later observations of Rüdinger, Tröltsch, and Weber-Liel by a consideration of the relations of the Eustachian tube to the naso-pharyngeal cavity.

On removing the mucous membrane about the periphery of the pharyngeal opening of the Eustachian tube, there are revealed from three to five, or even more, tendinous and elastic bundles of fibres at the pharyngeal end of the hook of cartilage, and at the contiguous lateral wall of the tube, having no fixed points of insertion, but blending generally with the perichondrium of the tube. They vary greatly in size and character, being sometimes dense like elastic tissue, and of a yellowish color, or thinner, having more the character of connective tissue. They are found, on following their distribution, lying upon the connective tissue surrounding the levator palati mollis, and extending lower down into the connective tissue between the muscles of the pharynx and the pharyngeal mucous membrane, and in the submucous tissue of the lateral wall of the soft palate. When well developed they may be divided into a median and a lateral bundle, the former appertaining to the outer portion of the soft palate, and the latter to the lateral and posterior wall of the pharynx, in which they terminate, the fibres broaden, become more membranous, and are lost in the submucous tissue.

With the contraction of the muscles of the pharynx the fibres are drawn inwards and backwards, the posterior lateral portion of cartilage is separated from the anterior medial wall, and the ostium tubæ pharyngeale, with the contiguous parts, widely opened. If the fibres or the lateral portion of the soft palate are drawn downwards the walls of the tube approximate, while at the same time there appear in the tympanum symptoms which, according to Weber-Liel, are the result of secondary contraction of the musculus tensor tympani. On opening the tympanum from above, and drawing the fibres downwards, the movements of the membrana tympani and the ossicula are plainly seen. Another important factor in the ventilation of the middle ear through the Eustachian tube, by contraction of the pharyngeal muscles, is found in a fibrous network pertaining to the lateral portion of the tube and arising from the fibro-cartilago-basilaris and from the posterior lateral wall of the tube. On the under surface it forms a fine network, the spaces of which are filled by mucous glands on the lateral wall of the pharynx, the areolæ are larger, and the ends of the fibres terminate in fine connective tissue lying between the mucous and muscular coats of the lateral and posterior pharynx

walls. The action of this network during contraction of the pharyngeal muscles may be deduced from the above description.

In the second portion of his paper the author treats of *accessory cartilage in the region of the tube*, and of the *division of the cartilaginous tube into several parts.* This subject is treated of by Luschke and Henle. The accessory cartilages observed by Zuckerkandl are distributed upon the roof and walls and the ligaments of the tube. One flattened plate of cartilage was found between the external mucous coat and the cartilage proper on the curve of the lateral wall. Two readily movable accessory cartilages were found on the lateral inferior surface of the cartilage proper, to which they were attached by dense connective tissue ; this is their most frequent location. In one specimen, in which the ligamenta salpingo-pharyngea and palatina were especially developed, four accessory cartilages were found among their fibres. In addition, in one of the specimens examined the medial portion of the tubal cartilage comprised seven divisions ; four of these included not only the outer but also the inner face of the cartilage, while of the remainder two were confined to the outer and one to the inner surface. The same characteristics were found at the termination of the cartilaginous hook, the distinct portions being more or less firmly attached by connective tissue.

PROF. CYON contributes a paper to the December number (1872) of Pflüger's Archiv on the *function of the semicircular canals.* The results of his investigations may be condensed under the propositions that a definite perception of the position of the head is necessary to the maintenance of equilibrium, and that this perception has its origin in the semicircular canals, each canal having a certain determined relation to certain grades of position, and that the derangements of motion consequent upon division of the semicircular canals may be classified under three heads : 1, Derangements of equilibrium as a direct result of the injury ; 2, Forcible movements as a result of the irritation consequent on the abnormal sense of hearing induced thereby ; 3, Consecutive symptoms, occurring some days after the operation, from the resulting inflammation of the cerebellum.

HUGHLINGS JACKSON reports the case of a man, thirty-one years of age, suffering from *auditory vertigo.* Three months previous to his admission to the London Hospital he was suddenly attacked with severe vertigo and subsequent vomiting. He slept well that night, but had several attacks of essentially the same character afterwards. He was not aware of any deafness, but the examination showed that he did not hear at all from the right ear ; twelve months previously he had placed a piece of tobacco,

soaked in rum, in the ear, for relief from toothache, and the syringe brought away a large plug of cerumen with bits of tobacco; he had one slight attack after the meatus was cleared. Such cases, says the author, have been described very recently, and most ably, by Knapp (Archives of Ophthalmology and Otology, vol. ii. No. 1). But it is not widely known that ear disease gives a sufficient explanation of the group of grave nervous symptoms mentioned. The tendency is to put down the giddiness, reeling, and vomiting to disorder of the digestive organs, and especially to some affection of the liver. But in the above reported case, and in many others, there is no dyspepsia, and no evidence at all of liver affection. It is not denied that there is a *vertigo a stomacho laeso*; but it is asserted that of the numerous causes of vertigo aural disease is a very important one. The "bilious vomiting" is what misleads so very often in diagnosis.

Bilious vomiting is, however, of no particular value as evidence of disease of the liver. Bile will always be found in the ejecta after long-continued and urgent vomiting, however caused; and as to vomiting itself it is a symptom which is found under the most different circumstances: it is found with cerebral tumor, renal calculus, Bright's disease, and, as we see, with aural disease. Those who would not accept the explanation of the dependence of vomiting, reeling, and vertigo on ear disease, are at any rate bound to examine the ears of patients who suffer those symptoms. If they do, they will be struck by the frequent coincidence of noises in the ear, deafness, etc., with the paroxysmal occurrence of the symptoms mentioned. Knapp has observed in some cases of Ménière's disease what he calls a contraction of the field of audition (analogous to contraction of the field of vision); there is, in other words, deafness for certain groups of musical sounds, and this he considers is positive proof that the cochlea is implicated, in addition to the semicircular canals. Dr. Hughlings Jackson thinks that the "canal" division of the auditory nerve is for the regulation of intervals of movements (for more automatic movements occurring in the intervals of a succession of voluntary movements). Hence the association with the other division for musical sounds; both divisions are in action in dancing to music. He believes that the symptoms of sea-sickness may be explained on the supposition that the contents of the semicircular canals are rudely dealt with in the unaccustomed movements of sailing on a rough sea.

Lucae reports *ten cases* in which he repeatedly removed from the ear masses corresponding in appearance and structure to the so-called *cholesteatoma*, or pearly tumor, consisting of large polyhedral cells, with a small quantity of cholesterin. From his examination into the constituents of these tumors, Lucae is inclined to reject the term cholesteatom, as dis-

tinctive of their character, in order to avoid confounding them with cysts containing cholestearin, to which the name is applicable.

In all of his cases there was deafness, generally excessive, and in six cases cerebral symptoms. In the majority the instillation of a solution of carbonate of soda and syringing sufficed for treatment, and the hearing was considerably improved. With one exception there existed in all the cases a chronic purulent inflammation of the middle ear, accompanied by granulations, and in four cases by caries. That these masses came from the middle ear, and also even from the antrum mastoideum, Lucae was convinced, especially by the ninth case, in which a mass was removed from the opening in the carious mastoid; and in the tenth case, death resulting from pyæmia, in which the post-mortem examination revealed a large mass in the mastoid cavity, which corresponded exactly in its constituents with the masses removed from the middle ear during life. The fact observed by Lucae, and also by Virchow, Gruber, and Schwartze, of the coincidence of polypoid growths in these cases, pointed to their possible influence as a cause of this complication. The post-mortem of a case of purulent meningitis and cerebral abscess was further confirmatory. On removing the discolored dura mater, which easily separated, the petrous portion of the temporal bone was found also discolored, smooth, and infiltrated with pus; the tympanum was filled with a pearly tumor undergoing purulent degeneration, the reddened mucous membrane, especially about the roof of the antrum mastoideum, was covered with polypoid granulations, which were covered in many places with shining layers of epidermis. Microscopic examination showed these excrescences to consist of a very vascular granulation tissue, interspersed with cysts. Lucae infers from this condition that in purulent granular inflammation of the middle ear a new growth of epidermis takes place, the old detached layers of which accumulate in the cavities of the middle ear. This explanation does not, however, answer in all cases, as Lucae has reported a case in a former paper in which a pearly tumor was found in the middle ear, the mucous membrane showing no traces whatever of inflammation or granulations and the membrana tympani being intact.

H. Wendt reports *eleven similar cases.* In three the mass was confined to the tympanum, in eight it was found in both tympanum and meatus, in two cases similar masses were discharged through the Eustachian tube, and in five cases the author observed the repeated formation of epidermis-like layers upon the surface of the mucous membrane. In one case, resulting fatally from meningitis and cerebral abscess, Wendt had opportunity to make an examination, and gives the results of his clinical observations as follows:

1. In the external ear, and also in the middle ear, are sometimes found peculiar accumulations resembling cerumen.

2. The occurrence of these masses is principally the result of a desquamative inflammation and the redundant formation and detachment of cells, similar to those forming flakes of epidermis, from the mucous membrane of the middle ear, the epithelial coat of the membrane taking on a character similar to that of the dermis, with the formation of a rete Malpighii, and of flattened cells, which, when excluded from the air, undergo a partial fatty degeneration.

3. They cause deafness in a moderate degree when dry and uncomplicated with serious changes in the sound-conducting apparatus; but in a high degree under the opposite circumstances, when they become swollen, either spontaneously from the presence of fluid secretion in the ear, or as the result of extraneous causes, moisture from syringing, etc.

4. They may give rise to serious changes in various parts of the ear, the petrous bone, and even the contents of the cranial cavity, in consequence of the pressure exercised by their softening and swelling, as well as by their growth, and possibly also by the absorption of fluid resulting from their decomposition, or secondarily from their presence in the ear.

5. Their removal, although painful, and often tedious, is unquestionably demanded.

6. It is not improbable that similar masses, resulting from chronic inflammation of the walls of the external auditory passage, may enter the middle ear, in consequence of defect of the membrana tympani, and give rise to similar symptoms.

7. The accumulations consisting of epidermis cells, and distinguished as cholesteatoma of the petrous bone, are also to be considered as the product of a desquamative inflammation in the middle or external ear, so long as a comprehensive examination gives no other indication of their origin.

In this connection Dr. J. Orne Green reported a case at a late meeting of the *Boston Society for Medical Observation*, which illustrates the effects of long-continued presence of a foreign body in the meatus. A firmly impacted mass of cerumen having been removed by syringing, with considerable improvement in hearing, a further examination showed more than the usual redness and erosion at the inner end of the passage, and exploration with the probe revealed a small surface of carious bone on the floor of the passage, a short distance from the membrana tympani. The greatest degree of pressure seemed to have been confined to this point, as the membrana tympani was intact and gave no evidence of having been in contact with the ceruminous mass.

The same author publishes at length in the Boston Medical and Surgi-

cal Journal notes of *three cases of mastoid inflammation.* The first patient, a girl eight years of age, had suffered from purulent inflammation of both middle ears for some time. With an access of inflammation in the left ear, the trouble extended to the mastoid cavity. When first seen was in bed, very weak, extremely emaciated, skin hot and dry, tongue coated, and pulse 130; the left meatus was filled with pus, and behind the left ear was a large diffuse abscess. An opening two inches in length was made over the mastoid, with the evacuation of six ounces of thin and offensive pus; the whole bone was denuded for four inches towards the vertex and one inch behind the mastoid, but was not softened at any spot; a cloth tent was inserted and stimulants and narcotics ordered. During the week following the patient improved, having but one chill, though there were exacerbations of fever several times a day, and the pulse came down to 100. Eight days after the first visit there was a recurrence of chills, cough, and brownish expectoration, rapid respiration and accelerated pulse, apparently relieved by enlarging the original incision.

Five days later diffuse swelling over the back of the neck showed itself, and an abscess formed on the side of the neck and broke. An attack of pneumonia supervened, and this was followed by post-pharyngeal abscess and by abscesses on the opposite side of the neck, occiput, and temple. Notwithstanding all these complications, the case steadily improved. The fistula continued to discharge, however, and an operation was finally permitted. The mastoid being exposed by incision through the fistula, a small opening was found to communicate with the cells. The carious walls of the fistulous opening were removed with the gouge, and warm water syringed through the tympanum. From this time the patient continued to improve, no bad symptoms followed the operation, and in ten days the wound had entirely healed.

In the second case a woman, sixty-five years of age, had suffered from acute inflammation of the middle ear for six weeks. One week after its commencement a free discharge from the meatus showed itself, with but little relief from pain, which was referred chiefly to the region of the mastoid. The left membrana tympani was swollen and inflamed, with a large perforation in the posterior segment, the tympanic mucous membrane was granular, but there was no swelling, or even tenderness, around the ear or over the mastoid. With a triangular borer the bone was perforated, on a level with the meatus, to the depth of one-third of an inch, and its withdrawal was followed by the discharge of about two drachms of inoffensive pus. The operation afforded considerable relief, and the patient continued to improve, and fifty-two days later the opening in the membrana tympani had healed and the discharge from the mastoid nearly ceased.

In the third case a boy, fifteen years of age, with severe subjective symptoms, accompanying inflammation of the left mastoid. Wilde's incision liberated a quantity of thick grumous pus. Six days after operation the opening in the membrana tympani had healed and the discharge had ceased.

Dr. Green gives further the indications for the opening of the mastoid, and lays deserved stress upon the value of the operation. "At the time

of the incision the bone should be examined to see if any fistula exist in it, and if such is found it should be exposed and thoroughly syringed out. The place at which this fistula forms is of considerable importance in aiding us in our search, and also in deciding where the bone ought to be trephined, in case such an operation becomes necessary. In all of the cases which I have seen, this fistula has been nearly in the middle of the mastoid, never at the extreme tip nor at the extreme upper part, although in both of these places the bone is very thin."

In relation to the point to be chosen for perforating the mastoid, Dr. BEZOLD, following the descriptions given by Schwartze and Eysell, has made further examination into the anatomical proportions of the mastoid process with especial reference to this operation.

The thickness of the outer wall he considers as dependent principally upon two classes of development ; with larger muscular development the bone, especially the posterior portion, is thicker and more irregular, while in a person of more slender figure it is thinner and less uneven. A still greater influence upon the thickness of the outer wall is found in the degree of development of the mastoid cells. Where the cells are large and numerous, a section on a level with the meatus shows the portion of the pars mastoidea, behind the fossa sigmoidea, to be quite solid. From this point forward the cells encroach upon the substance of the outer wall, which becomes thinner towards the meatus, until about the middle ; towards the meatus one or more cells come so near to the surface as to be covered by bone no thicker than paper. The thickness of the wall diminishes also toward the point of the process.

The inner wall of the pars mastoidea is, as a rule, thinner than the outer wall, its diameter varying considerably in different cases. At some points there may be openings into the fossa sigmoidea, though these are by no means so common as similar openings through the tegmen tympani.

JOS. GRUBER *reports a case of facial paralysis, accompanying purulent inflammation of the middle ear, which disappeared on paracentesis of the membrana tympani and liberation of the secretion.* The principal interest in the case, aside from the evidence which it bears to the possibility of paralytic symptoms occurring temporarily as the result of a remediable affection of the middle ear, lies in the fact that with reaccumulation of secretion the paralysis recurred, to be relieved so soon as the discharge became free, or so soon as the pressure which it caused was removed by the use of the air douche, from which circumstance Gruber diagnosticates defect in the wall of the canalis Fallopiæ.

OPHTHALMOLOGICAL REVIEW.

By E. GRUENING and H. KNAPP.

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10. W. Goldzieher. The tumors of the optic nerve. *Graefe's Arch.*, xix. 3, p. 119, etc.

11. Dr. Annuske. Optic neuritis in connection with cerebral tumors. *Graefe's Arch.*, xix. 3, p. 165, etc.

12. Landsberg (Görlitz). Ein Fall von Aderhautsarcom. (A case of choroidal sarcoma—coincident with metastatic irido-choroiditis). *Zeh. Klin. Mon.*, 1873, p. 487, etc.

13. Steffan. Zur Anaesthesiae Retinae mit concentrischer Sehfeldbeschränkung. *Zeh. Klin. Mon.*, 1873, p. 411, etc.

14. C. Schweigger. Hyperæmie und Entzuendung des Sehnerven in seinem orbitalen Theile. (Hyperæmia and inflammation of the orbital part of the optic nerve. 6 cases.) *Zeh. Klin. Mon.*, 1874, p. 18, etc.

15. Critchett. Einige Winke bei der Behandlung noch nicht operationsreifer Staare. (Some hints concerning the treatment of immature cataracts.) *Zeh. Klin. Mon.*, p. 459.

16. L. De Wecker. De l'Iridotomie. *Ann. d'Ocul.*, lxx., p. 123, etc., 1873, and *Zehender's Klin. Mon.*, 1873, p. 377, etc.

1. Herzenstein, Demtschenka, and Wolferz suppose that the secretory filaments of the nervus lachrymalis are in reality fibres of the fifth nerve. Reich instituted a series of experiments with a view of determining the influence of the fifth nerve upon the secretion of tears. He decapitated a number of rabbits, sheep, dogs, and cats, split their heads into lateral halves, cut the fifth nerve at its point of exit from the brain, and applied the electrodes of Du Bois-Reymond's sledge apparatus to the peripheral end of the nerve. This irritation was not followed by an increase in the flow of tears, owing, as Reich thought, to the circumstance, that in the split head of the animal the lachrymal gland contains no blood and is therefore incapable of performing its function. It is well known that in the rabbit the lachrymal and inferior ophthalmic arteries are given off from the internal maxillary. This anatomical peculiarity permits the performance of the experiment in such a manner as not to interrupt the circulation of blood in the lachrymal gland. Reich modified the experiment accordingly, without being able to convince himself that an irritation of the peripheral end of the root of the fifth nerve is followed by an increase in the secretion of tears.

A third series of experiments was made. It has been observed that an irritating agent, *e.g.* oleum sinapis, applied to the mucous membrane of one nostril will not only cause a flow of tears from the corresponding eye, but also from that of the other side, though the latter be hermetically covered and the other nostril thoroughly plugged. If centrifugal secretory nerves exist in the root of the fifth nerve, the increase in the secretion of the lachrymal gland on the side opposite the point of irritation must cease after the division of the root of the fifth nerve. In eight cases the author divided the root of the fifth nerve (confirmed by post-mortem examination), but in no case a diminution in the flow of tears from the eye opposite the point of irritation was noticed. Having thus excluded the secretory nerves of the lachrymal gland from the root of the fifth nerve, the author sought them in other nerves. It was found that upon irritation of the cervical portion of the sympathetic nerve the secretion of tears became increased. After extirpation of the ganglion cervicale supremum no alteration in the flow of tears ensued. It must therefore be supposed that the secretory filaments are given off from a point above the upper cervical ganglion, perhaps from the medulla oblongata. Further experiments proved that the facial and trochlear nerves do not influence the secretion of tears. The author did not deem it necessary to seek the secretory filaments in the oculo-motory and abducens nerves, since

dryness of the eyes is not observed as a symptom of paralysis of these nerves.

The conclusions which the author draws from his various experiments are the following: The centrifugal secretory filaments of the lachrymal gland emanate from the medulla oblongata most probably in conjunction with fibres of the sympathetic nerve, and join the fifth nerve at its periphery. The reflex centres, which participate in the act of reflex secretion of tears, are most probably situated in the medulla oblongata.

E. GRUENING.

2. The observation that phenomena of accommodation occur in aphakial eyes has led FÖRSTER to assert that the crystalline lens is not the sole organ of accommodation, but that the cornea is likewise capable of assuming varying degrees of convexity. This assertion has led to the investigations of Mannhardt, Coert, and Abadie, who not only deny the participation of the cornea in the act of accommodation, but also the existence of phenomena of accommodation in aphakial eyes. WOINOW enters upon this question, and comes to the conclusion that in aphakial eyes certain changes occur which may be regarded as phenomena of accommodation. These, however, do not depend upon changes in the curvature of the cornea. The ophthalmometer shows that the convexity of the cornea remains unaltered during the act of accommodation.

Woinow examined eleven aphakial eyes according to a new method by which he was able to determine the exact distance at which circles of dispersion appear. It is well known that glasses colored with cobalt do not only transmit blue but also red rays. If the narrow aperture of a screen be covered by such a glass and the opening illuminated, the coloration changes with the various degrees of accommodation. When the eye is accommodated for the aperture a uniformly violet color is seen, but when accommodated for a nearer or farther point, the aperture appears surrounded by blue or red zones, which very distinctly indicate the circles of dispersion. Woinow estimates the average value of the range of accommodation in aphakial eyes at $\frac{1}{28}$, which, by the instillation of atropine, may be reduced to $\frac{1}{40}$.

E. G.

3. GIRAUD-TEULON, in a communication made to the Société de Chirurgie de Paris, Apr. 7, 1874, stated that COCCIUS had added to the binocular ophthalmoscope an eye-piece constructed according to the principle of an ordinary opera-glass (Galilean telescope). It was adapted for near objects, placed before the ocular orifices of the stereoscopic box of the instrument, and produced about double the magnifying power of the ordinary erect ophthalmoscopic image.

Giraud-Teulon obtains the same magnifying power in a simpler way,

both for the erect image and the inverted. He places a lens (object-glass) of a positive focal distance of $2\frac{2}{3}$ inches between the mirror and the rhomboids, and another lens (eye-piece) of a negative focal distance of 2 inches behind each double prism. This simplification consists in the using of the rhomboids as the axes of the tubes of the opera-glass.

H. KNAPP.

4. STAMMESHAUS follows the principle of JAVAL,* who used for determinations of refraction a Galilean telescope as an ophthalmoscopic eye-piece, by which, at the same time, he "saw the retina with a magnifying power hitherto unknown." St. places a strong convex glass, for instance $+5\frac{1}{2}$, before the eye observed, and then examines the eye, in the erect image, by placing strong concave glasses behind the mirror. The stronger the glass, the farther he must move from the patient, but the greater is the magnifying power. If, for instance, a case of real $M=\frac{1}{6}$ (or of artificial $M=\frac{1}{6}$ by putting $-5\frac{1}{2}$ before the eye) is examined with

(1) $-5\frac{1}{2}$	at the	distance	of	$\frac{1}{2}''$,	the	image	is	14,6	times	magnified.
(2) -5	"	"	"	$1''$,	"	"	"	15,6	"	"
(2) -4	"	"	"	$2''$,	"	"	"	19,6	"	"
(3) -3	"	"	"	$3''$,	"	"	"	26,1	"	"
(4) -2	"	"	"	$4''$,	"	"	"	39,1	"	"

At the same time there is a corresponding contraction of the ophthalmoscopic field of vision, which at the distance of $1''$ is only half as large as when seen at the distance of 15 millimetres, at two inches about one-fourth, at three inches one-ninth, and at four inches one-nineteenth of the extent of the field, obtained from a distance of 15 mm. The author says that the remarkable distinctness with which, by this method, he could see the minute details of the fundus, elicited his greatest interest. The reviewer has tried the method several times, but thinks that for ordinary cases with undilated pupils the advantage of a greater image does not compensate for the inconvenience of the examination, nor for the most unpleasant contraction of the ophthalmoscopic field of vision. In cases of excessive myopia, with wide pupils, the employment of strong concave corrective lenses, at correspondingly great distances between the examiner and the eye examined, may be of advantage in studying minute changes of the background.

H. K.

5. PROF. F. C. DONDERS expresses his opinion on the *origin of the light-streak* on the retinal vessels as follows: "The explanation, first given by *Van Trigt* and later by *Ed. Jaeger*, according to which the light-streak in the ophthalmoscopic image of the retinal blood-vessels depends

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* Annales d'Oculist., tome 63, p. 287.

on *reflection* from the anterior wall of the blood-vessel (Van Trigt), or on reflection from the anterior surface of the blood-column (Jaeger), was contested by *E. G. Loring*,* who ascribed it to *refraction;* but it was defended, apparently with good reason, by *Schneller*.† The results recently arrived at by Prof. *Becker* ‡ were, again, doubtful.

"I firmly hold to the explanation of Van Trigt, mainly for the following reasons:

"1. The blood cylinder in the vessels of warm-blooded animals (Becker examined frogs only) is non-transparent: consider that light has to traverse this cylinder twice, in order to form, according to the view of Loring, a light streak by refraction.

"2. The light, after passing twice through the blood-column and undergoing the numerous reflections and refractions on both sides of the blood-corpuscles, must be totally diffuse and unfit to produce an image.

"3. Such an image would be situated in front of the wall of the vessel, not behind it.

"4. The light-streak remains unchanged when an artery runs directly over a wide, darker vein which cannot send back the same kind of light through the artery. Furthermore, the tapetum of animals and morbid changes, by which the fundus oculi becomes brighter, have no material influence on the appearance of the light-streak."

The experiment of BECKER alluded to was the following: When the mesentery of a frog was placed under the microscope, and lighted from below, there appeared a light-streak similar to that seen with the ophthalmoscope.

6. SCHNELLER'S experiments and statements are, in part at least, as far as can be judged without repeating them, correctly refuted by LORING.

7. The last publication of Loring is a reprint of the last pages of the preceding one. It enumerates various changes in the background of the eye, in which the light-streak is either altered or absent. The paper may be summed up in the following sentence: All changes in front of the retinal blood-vessel diminish the brightness of the light-streak, or make it disappear altogether, whereas changes behind the retinal blood-vessels have no influence on the light-streak. H. K.

8. M. POLAILLON presented, in the *Société de Chirurgie* of Paris, the body of a new-born child which had several deformities: hare-lip, cleft palate, webbed fingers, a large encephalocele which burst during birth

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* Archives of Ophthalmol. and Otol., ii. 1, pp. 95–106.

† Graefe's Arch. f. Ophthalm., xviii. 1, pp. 113–126.

‡ Graefe's Arch., xviii. 1, pp. 280–284.

and caused the death of the child. From each cornea a cutaneous cord, three millimetres thick and eight to ten millimetres long, passed downward and slightly inward upon the outer surface of the lower lids. A probe could be passed underneath the right one, whereas the left was totally adherent. Polaillon thinks that in his case the cutaneous prolongation destined to form the crystalline body has persisted and was even hypertrophied, so as to produce two cutaneous folds. H. K.

9. Prof. Michel records the following remarkable case: A girl sixteen years of age suffered from elephantiasis of the left leg, the condition of which rendered amputation necessary.

Six days after the operation, the girl died of septicæmia.

At the post-mortem examination a considerable enlargement of the chiasma and right optic nerve was accidentally discovered. The left optic nerve showed its normal dimensions. During life the eyes had exhibited no anomaly, and had therefore not been examined.

The right optic nerve was enlarged to the size of the little finger throughout its course, from the chiasma to the optic foramen. In the foramen it did not exceed its normal dimensions. The intra-orbital portion of the nerve showed a marked thickening, which, however, involved chiefly the lower half of the trunk.

The chiasma appeared considerably larger than normal. The enlargement was mainly due to an inordinate development of the right half. From the upper surface of the chiasma sprang a globular protuberance, which was covered by normal pia mater.

The chiasma, protuberance, and optic nerve had a tough and elastic consistency, and showed no anomaly as regards color. The pia mater could be detached easily.

Microscopic Examination.—The connective tissue of the septa of the optic nerve was quite normal, and surrounded the nerve-fibres in the ordinary manner. There was no proliferation of nuclei of the connective tissue of the septa. Within the field limited by a connective tissue septum a peculiar arrangement of densely crowded fibres was noticed. These fibres formed two zones, an outer and an inner zone. In the outer zone the fibres showed a radiating, in the inner zone a concentric, arrangement. Among these fibres there were regular rows of roundish dots resembling transverse sections of delicate fibres. The nerve fibres had their normal appearance, but in the substance surrounding them many dots similar to those mentioned above were found.

The peculiar arrangement of fibres was found everywhere in the enlarged optic nerve. The nervous fibres of the chiasma were similarly enclosed by zones of dense fibres, but not in so peculiar and regular a manner.

Aside from the roundish dots described, there were found between the layers of these densely crowded fibres a great number of nuclei. These corresponded to the nuclei of normal glia cells.

The process of isolating the densely crowded fibres was very difficult. In teased preparations they exhibited the physical properties and chemical reactions of elastic fibres. The glia nuclei were surrounded by narrow zones of protoplasma. These cellular elements had no projections, and in no case could a continuity be traced between a fibre and a cell. The cellular elements were found in great number in the protuberance of the chiasma.

The nervous fibres did not seem to have perished in this pathological process. It was estimated that the enlarged right optic nerve contained as many nerve-fibres as the left.

The hyperplasia of the optic nerve and chiasma was due to a proliferation of their normal cellular elements and to a peculiar transformation of the finely granular interfibrillary substance into elastic tissue. According to Virchow, we should designate this hyperplasia as *sclerosis*. *Sclerosis* differs from glioma in the following points: 1. *The nervous elements are not* totally destroyed. 2. The proliferation of cells takes no prominent part in forming the tumor. E. G.

10. Tumors springing from the optic nerve and its sheaths have hitherto been so rarely observed, that N. Goldzieher could only gather six well-authenticated cases from literature. To these six tumors he adds three, which he had the good fortune to obtain for examination.

I. The first case was that of a boy, 10 years of age, who presented himself at the ophthalmic clinic of Heidelberg. On examination a moderate degree of left exophthalmus was found. The mobility of the eyeball was equally limited in all directions. Thorough palpation in the anæsthetized patient revealed the presence of an orbital tumor. The conjunctiva of the globe and the lids was normal. Acuteness of vision diminished. The boy counted fingers at a distance of 16′, and read Jäger 16. Refractive media perfectly clear and transparent; optic papilla somewhat swollen, its outlines blurred. The retina appeared hazy, and presented a striped appearance. The veins were markedly injected and tortuous. Along both sides of the retinal vessels white bands were seen.

Diagnosis: Neuro-retinitis o. s., in consequence of orbital tumor.

The right eye had E. and S. $\frac{20}{20}$.

Prof. Becker removed the left eyeball, together with the tumor.

The wound healed rapidly, and the boy made a speedy recovery.

Inspection of the removed mass showed that immediately behind the

globe the optic nerve passed into a neoplasm of oval shape, measuring 34 mm. in length, and 32 mm. at its point of greatest thickness. The substance of the tumor was hard, with the exception of a circumscribed spot which gave the sensation of fluctuation. The tumor was hardened in Müller's fluid, and subsequently divided, in connection with the eyeball, in a horizontal plane. For a short distance behind the globe the optic nerve was apparently normal; it then divided into two branches, the larger of which took its course, as a distinct trunk, along the inner periphery of the tumor, while the smaller passed into the growth, and here separated into fibres which spread throughout the mass of the growth. At the posterior end of the tumor all the fibres were again collected into one single trunk. The surface of the tumor was covered by the outer nerve-sheath, the connection of which with the sclerotic could be easily traced.

Microscopical Examination.—In transverse sections the outer sheath appeared perfectly normal. The inner sheath was enormously thickened, and from it broad and solid bands of connective tissue penetrated into the nerve. The nerve-bundles were separated by thick septa of connective tissue, which contained numerous blood-vessels. The nerve-substance was apparently unaltered. At that portion of the tumor which gave the finger the sensation of fluctuation, the connective tissue framework consisted of delicate fibres, crossing one another at various angles. The interstices thus formed were filled with mucous tissue.

The tumor was designated a fibroma myxomatodes, which had originated in the inner sheath of the optic nerve.

The swelling of the papilla was evidently due to the proliferation of connective tissue. In the retina nothing abnormal was found, with the exception of a marked injection of the veins. It was, however, observed that the vitreous was attached to the limitans interna. This, according to the author, occurs in all those cases in which, during life, the retina appears hazy. The choroid was normal. The boy was seen one year after the removal of the growth; he then enjoyed good health.

The other two cases were clinically observed by Dr. BERLIN, who also removed the tumors.

CASE II.—A child of 4½ years presented, on the right side, a considerable exophthalmus. Mobility of eyeball limited in all directions. Cornea diffusely opaque; ophthalmoscopic examination therefore impossible. By palpation under chloroform a cylindrical swelling was discovered behind the globe. Dr. Berlin diagnosticated a sarcomatous tumor of the optic nerve. Extirpation of the tumor in conjunction with the eyeball.

The growth began at the posterior pole of the eye, and surrounded

the optic nerve completely. Consistency spongy. The surface was covered by the outer nerve-sheath. The microscope showed a reticular arrangement of delicate fibres, at the points of intersection of which large nuclei, encircled by narrow zones of protoplasma, were embedded. At some points the reticular structure was replaced by a finely-striped tissue interspersed with a varying number of nuclei. These conditions undoubtedly were characteristic of *glioma*.

The tumor contained a number of yellowish patches perceptible to the naked eye. The microscope showed that their substance consisted of mucous tissue. The neoplasm had its seat chiefly in the subvaginal space. The outer sheath appeared normal; the inner sheath was thickened, and contained a large quantity of nuclei. The proliferation of nuclei could be traced into the substance of the nerve trunk. The nerve-fibres were unaltered. The swelling of the papilla was due to a proliferation of its connective-tissue elements.

There were two points of interest connected with the retina:

1. The granular layers were considerably enlarged, owing to the presence of glioma cells. A direct continuity between the nerve-tumor and the gliomatous process in the retina could not be traced.

2. In the vicinity of the tortuous veins the retina appeared folded. This folding was in reality a microscopic detachment. According to the author's experience, such detachments occur, without exception, wherever retinal veins become varicose. Since the veins are inseparably connected with the retina, they must necessarily, by their enlargement, exert upon this membrane a certain degree of traction, in consequence of which a detachment from the choroid takes place.

Case III.—A child, 4 years of age, exhibited a considerable bulging of the left eyeball, the mobility of which was limited in all directions, especially upward. The ophthalmoscope showed an extensive white discoloration of the posterior retinal regions.

Diagnosis, retro-ocular tumor. Extirpation of the tumor in connection with the globe.

One year later relapse in the orbit.

Examination of the Tumor.—The tumor had the size of a walnut, and surrounded the optic nerve completely. Its substance was soft. The outer nerve-sheath was considerably thickened and infiltrated with numerous large cells. The tumor contained a large quantity of mucous tissue, but was chiefly composed of peculiar broad and shining fibres interspersed with nuclei. In the meshes of these fibres spindle-shaped cells, aggregated in concentric layers, were found. The tumor was very vascular. Its sarcomatous character well marked. Owing to the bad state

of preservation of the specimen, the condition of the nerve-fibres could not be ascertained. The fibrous septa were thickened and infiltrated with cells. The optic papilla was transformed into a swelling of mushroom shape, and consisted of fibrous tissue, numerous cells, and newly formed blood-vessels. In the retina, both granular layers and the inter-granular layer were preserved. The retina as a whole was thickened by the infiltration of sarcoma cells, which were chiefly found in the radiating connective-tissue fibres.

Anatomical Features of the Tumors of the Optic Nerve.—Two of the nine cases observed were insufficiently described, and must therefore be excluded. The remaining seven tumors belonged to the class of connective-tissue neoplasms. The larger number were fibromata springing from the inner sheath, the smaller number sarcomata and gliomata originating in the vaginal space. Every tumor contained mucous tissue either enclosed in distinct cavities or scattered among the other elements of the growth.

E. G.

11. From a number of observations on optic neuritis in connection with intracranial affections, and from a careful consideration of similar cases recorded in ophthalmic literature, ANNUSKE draws the conclusion that there exists an almost constant relation between optic neuritis and encephalic tumors.

In the first part of his paper he tabulates and analyzes 238 cases of tumor gathered from the works of the most illustrious clinicists, such as Abercrombie, Andral, Bright, Lebert, Friedreich, Bamberger, Griesinger, and others, and demonstrates that these cases, however minutely examined and well described, are but insufficiently observed with regard to the point in question, and cannot therefore serve as statistical material.

In many of these cases it is but vaguely noted that disturbances of vision existed, in others no allusion is made as to the condition of the organ of sight, and in only a few it is positively stated that the sight was not affected.

But even this positive statement becomes worthless, if we consider that the ophthalmoscope had not been used to explore the condition of the eye. It is well known, at least to ophthalmic surgeons, that optic neuritis *may* exist for some time without materially reducing the acuteness of vision.

In the second part of his paper the author considers cases of encephalic tumor collected from ophthalmic literature. His list embraces 43 cases. Out of these, 42 show either actual optic neuritis or atrophy of the nerve as a consequence of this process. One case in which the function of the eye was altered, though the ophthalmoscope failed to discover any anatomical lesion, is reported by Saemisch.

The observations of the author extend over fifteen cases in which the diagnosis of intracranial neoplasm was made. Double optic neuritis was a constant accompaniment of the disease. In five of these cases the diagnosis was verified by post-mortem examinations. E. G.

12. LANDSBERG (of Görlitz) relates the following remarkable case of sarcoma of the choroid complicated with purulent (metastatic) irido-choroiditis. A sterile woman of 28 years, with good eyes, had her hymen extirpated. Multiple abscesses in the labia and thighs followed. Some weeks after the operation, the left eye was suddenly taken with a violent inflammation which destroyed the sight in two days. The eye showed the symptoms of irido-choroiditis purulenta, as seen in cerebro-spinal meningitis. It continued irritated, however, for some months. Its tension was normal all that time. The eyeball was enucleated. On accidentally perforating the sclerotic during the operation, about a tea-spoonful of ordinary pus escaped. When the globe was opened a dense white spindle-celled sarcoma of the choroid made its appearance. There was no relapse, and the patient, at the time of the report, eighteen months after the operation, was in good health.

The author places this observation on record without comment. It seems to us that the sarcoma was in no way dependent on the metastatic irido-choroiditis, but that the coincidence of the two affections was accidental. H. K.

13. STEFFAN observed 16 cases of anæsthesia retinæ with concentric limitation of the visual field. Thirteen of the patients were between 10 and 15 years of age, two young ladies of 16 and 17 years, and one exquisitely hysterical woman of 42 years. In 14 cases both eyes were affected; in two, one eye only.

Steffan points out that *symptoms* of irritation are never absent in this affection: photophobia, blepharospasm, and sometimes facial convulsions. If the eyes are protected with blue glasses, an increase of the visual field and of the acuity of vision is noticed in some cases. He therefore thinks that the anæsthesia is secondary to a hyperæsthesia of the retina. To his mind this disease is a higher stage of development of the ordinary hyperæsthesia retinæ with normal S and F, which we see so often as the cause of the so-called asthenopia nervosa, and is independent of any condition of refraction or accommodation. The next stage shows hyperæsthesia of the retina in connection with concentric limitation of F, but S normal, and the third stage hyperæsth. ret. with concentric limitation of F, and diminution of S, which in his observations varied from $\frac{3}{4}$ to $\frac{1}{13}$.

The *nature* of this affection is essentially nervous. Overworked eyes,

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The *nature* of this affection is essentially nervous. Overworked eyes,

especially in school children and delicate or hysterical women, seem predisposed to it. A sudden commencement, upon which *Von Graefe* dwells, was not noticed by Steffan, but, on the contrary, a gradual development.

The *recovery*, which, according to Von Graefe, commonly may be looked for in several weeks, was protracted in the cases of Steffan: from one month to three years and nine months.

In regard to the condition of the *accommodation*, *St.* states that in six cases the accommodation was unaffected, in five there was paresis, and in the remaining five there was spasm of accommodation.

All cases recovered perfectly, and therefore the *prognosis* may be assumed as absolutely good.

St. mentions no *treatment*. We may therefore be allowed to state that *Von Graefe** recommends lactate of zinc, at first gr. $1\frac{1}{2}$, later gr. v. pro die. Furthermore, moderation of light, tonics (iron), and frictions of the skin after cold ablutions. A similar treatment: deprivation of light, administration of valerianate and lactate of zinc, and iron, ended in recovery in a patient of Dr. Pagenstecher,† at Wiesbaden. The author cautions against depletion, especially Heurteloup's artificial leech.

H. K.

14. SCHWEIGGER publishes six cases of *monocular amblyopia* without appreciable ophthalmoscopic alterations. He asserts that they originate in hyperæmic or inflammatory conditions of the *orbital* part of the optic nerve on account of their being *monolateral*. The cases are briefly, though scientifically, recorded, but, with the exception of Case II., the time during which they were under observation was too short to support the deductions the author draws from them. In Case I., ending in recovery, the time of observation was four weeks; in Case II., incomplete recovery, optic disc whiter than on the other side, time of observation five months; in Case III., acute amblyopia, unimproved; observation one month and a half, incomplete; in Case IV., acute amblyopia in myopia, od. normal, cured by Roman baths after strychnia and Heurteloup's had proved inefficient, observed one month; in Case V., recovery without treatment, observed two months, $S=\frac{10}{20}$, slight paleness of temporal half of left od.; in Case VI., acute amblyopia, duration of disease six weeks, restoration of S nearly complete; bottom of central excavation whiter than on the other side. Observed four weeks.

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* Zeh. Klin. Mon., 1865, p. 267.

† Zeh. Klin. Mon., 1866, p. 251, etc., and Pagenstecher's Klin. Beobachtungen, iii. 1866, p. 84, etc.

Bearing in mind the slow course of the majority of amblyopic affections, we cannot consider Schweigger's observations complete enough to furnish trustworthy conclusions. In Case V., for instance, the patient soon had a relapse for which he was treated in Heidelberg, and for the last six months the same patient has been under my own care with progressive amblyopia, and distinct atrophy of the optic nerve of *both eyes*. H. K.

15. In the discussion following CRITCHETT'S paper at the meeting of the German Ophthalmological Society at Heidelberg, WECKER, WEBER, HORNER, FÖRSTER, and others mentioned the increase of refractive power which eyes are apt to show when cataract sets in. M is increased, H is converted into E and M, and emmetropic people become myopic. After they have used convex glasses in reading for many years, they can read without glasses. The reviewer has also noticed this fact, and thinks that what is popularly called "*second sight*," is nothing else. At least all the cases of "second sight" that have been brought to his notice showed myopia with incipient cataract. Swelling of the crystalline lens by imbibition seems to be the most plausible cause of the phenomenon under consideration. H. K.

16. WECKER reviews the attempts at *iridotomy* made in the last century; furthermore he mentions the experience of Desmarres père, Bowman, and A. von Graefe on the subject, and then speaks of his own method. He distinguishes *simple* and *double iridotomy;* the former is applicable to eyes in which the crystalline lens is preserved, the latter to aphakial eyes. The instruments necessary for the performance of iridotomy are :—a lid speculum and fixing forceps as usual, two small lance-shaped knives with an arrest-piece, and a pair of *forceps-scissors* (pinces-ciseaux) of his own device. They act on the principle of the well-known Liebreich's forceps. The author speaks highly of their excellence : "Discarding all illusions to which an inventor is liable, I am convinced that they are the only scissors which can be conveniently used in cutting behind the cornea."

Simple iridotomy is indicated in central opacities of the cornea and lens, and is performed as follows :—When the lids are kept apart and the globe is steadied, the cornea is incised with the lance-shaped knife in a section perpendicular to the meridian in which the new pupil is to be located. If, for instance, the artificial pupil is to be placed directly inward, a vertical opening should be made outward into the cornea about a line from its centre. The knife is slowly withdrawn, the scissors are closed and cautiously introduced, and when their points reach the opposite free edge of the iris, they are a little opened, and the posterior branch is passed behind the iris. When the branches are pushed sufficiently far toward the insertion of the iris, the iris is divided by one rapid stroke, after

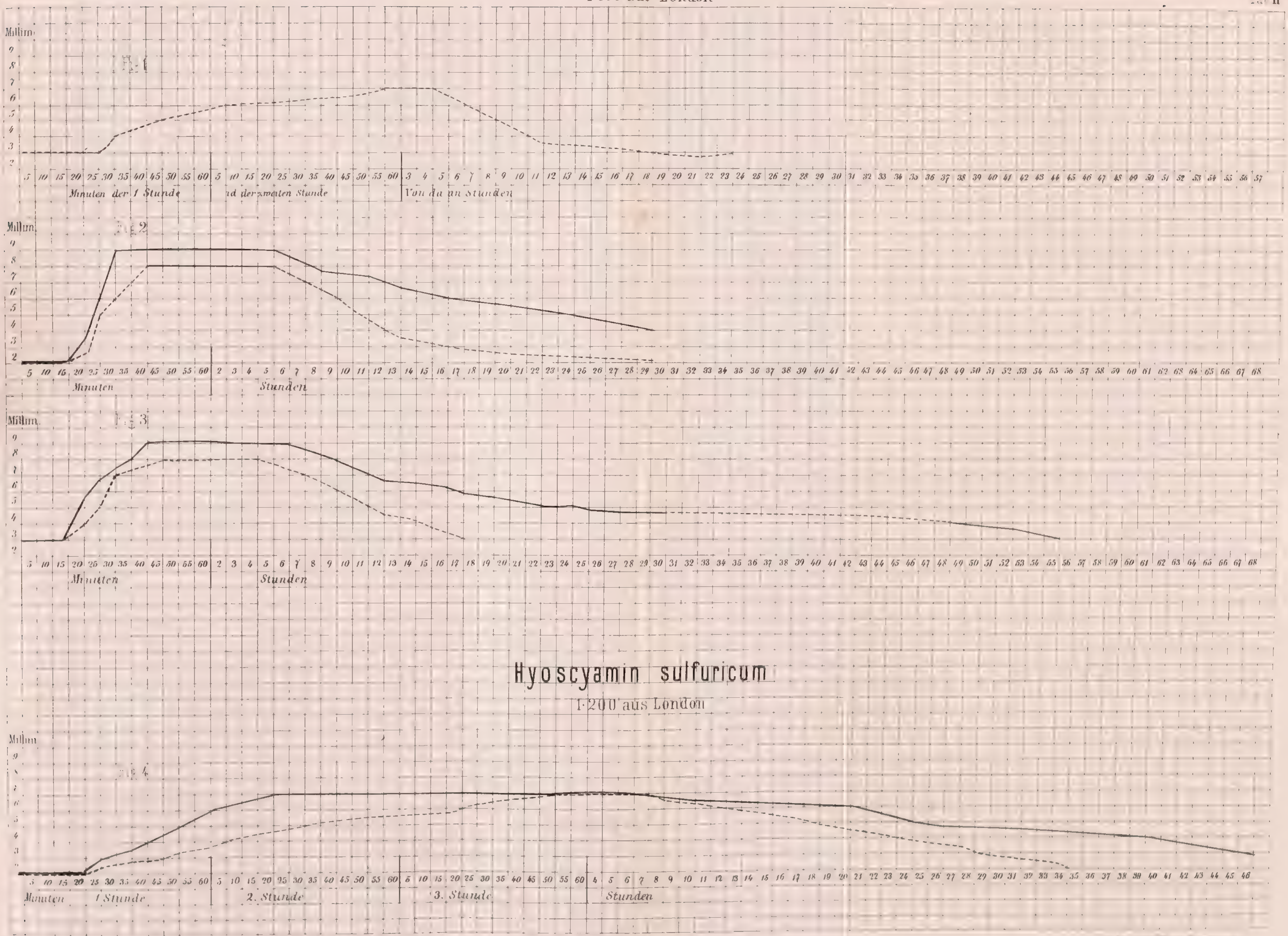
which the instrument is withdrawn. The coloboma is at first small, but will dilate afterward. Wecker says that this operation is difficult of execution, and requires a good deal of skill and delicacy.

The *double iridotomy* is indicated in cases of closure of the pupil after removal of the crystalline lens. It is practised in the following way:—The place of election for the incision is the point toward which the fibres of the iris converge. If, for instance, we have to deal with an occlusion of the pupil after a Graefe's extraction, the incision with the lance-shaped knife is made in the cornea about 1 millimetre from its margin. The point of the knife pierces the iris, and is pushed forward, to a certain extent, along its posterior face. When the knife is withdrawn, the forceps-scissors are introduced, one branch is passed behind the iris, through the opening made with the knife, and a rapid incision is made downward and inward. Then another incision is made downward and outward, so that the two incisions, starting from the same point, represent the shape of a Λ. The iris comprised between the two legs of this angle will retract and leave a triangular opening. In order to obtain the greatest gaping of the wound in the iris, the section should always be made in the sense of the greatest traction and distention exerted on the iris. *We should always cut in the direction of the radiating fibres, and perpendicularly to the circular fibres.*

The author asserts that the complete (?) absence of reaction after iridotomy, when compared with iridectomy or iridorrhexis, will convince every practitioner that iridotomy is the only operative procedure truly indicated in cases of pupillary occlusion after cataract operations. H. K.

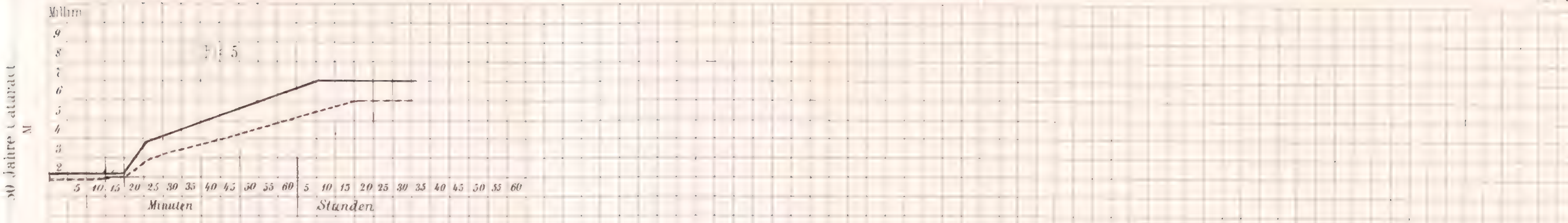
Hyoscyaminum purum

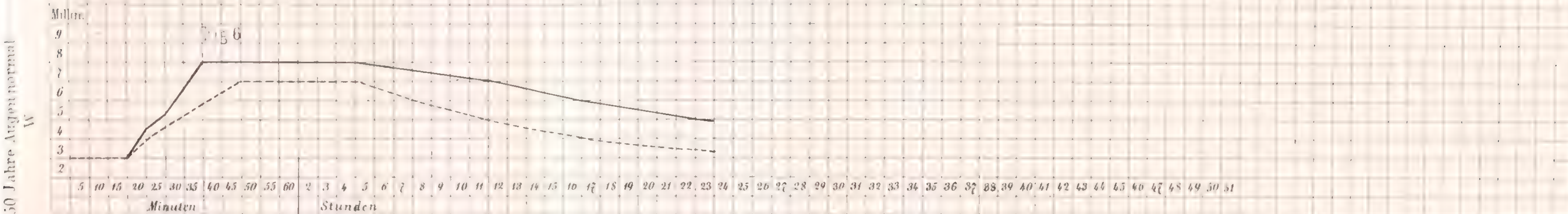
1·500 aus London



Hyoscyamin sulfuricum

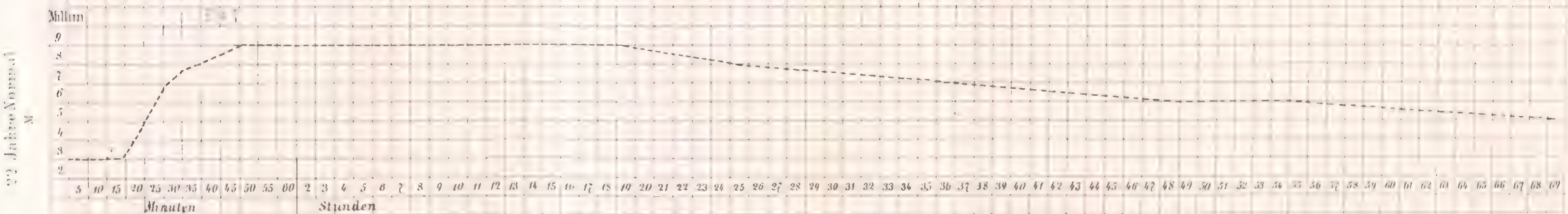
1 · 200 aus London

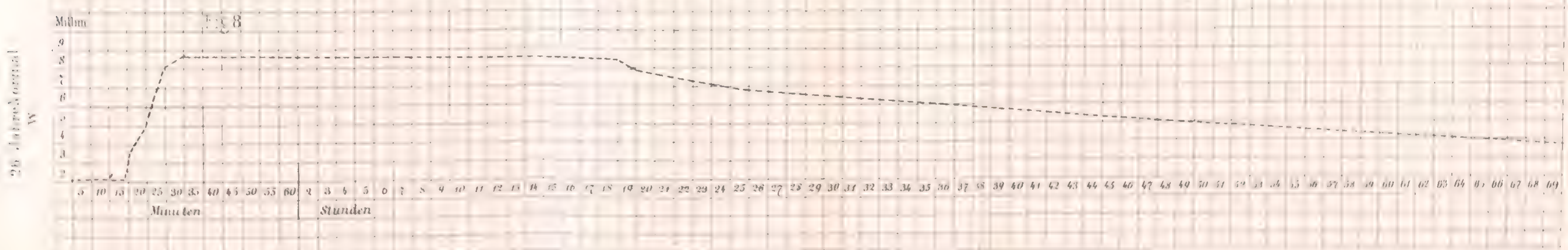




Hyoscyaminplättchen

aus Turin

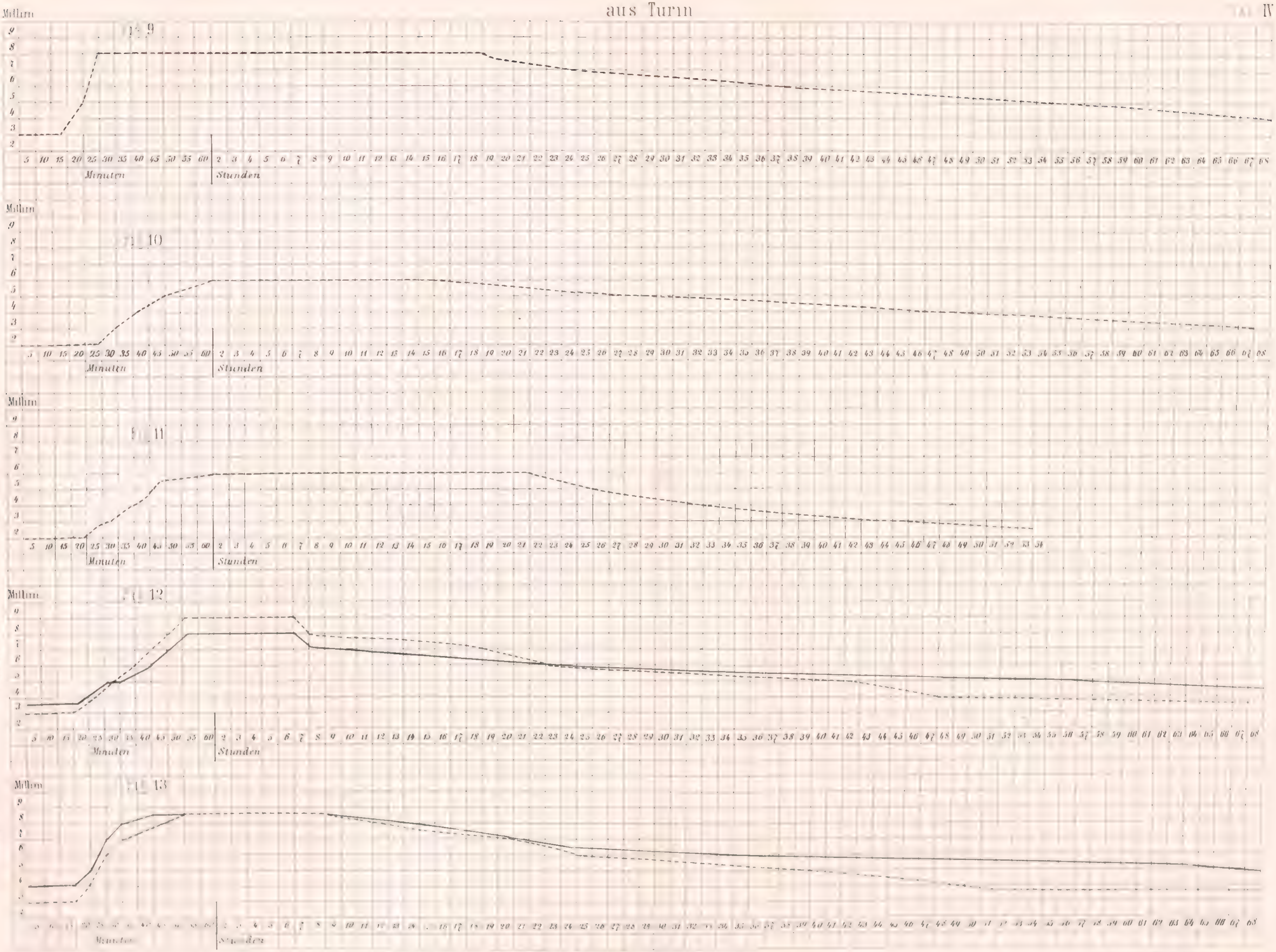




Hyoscyaminplättchen

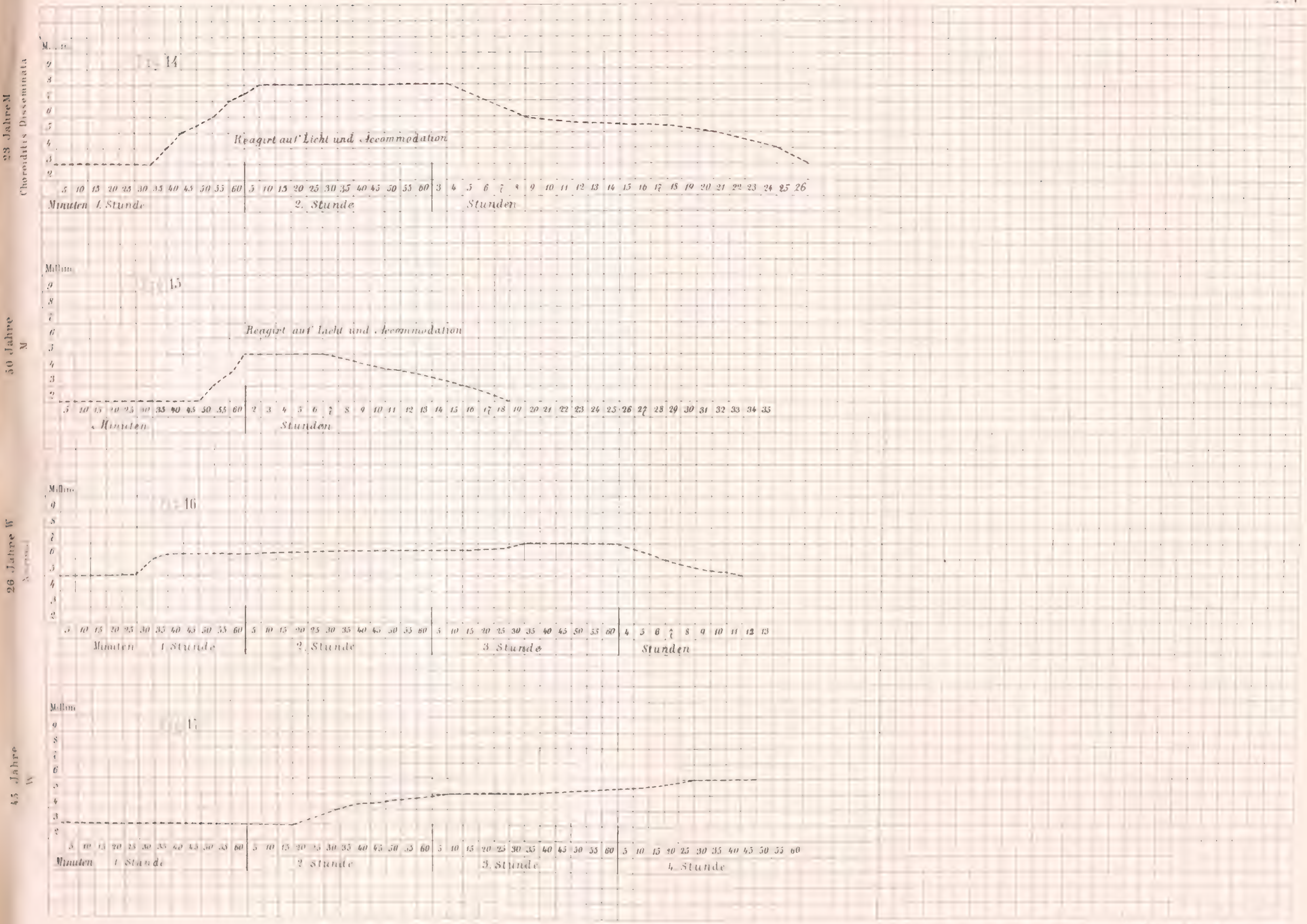
aus Turin

Taf. IV



Hyoscyaminum purum

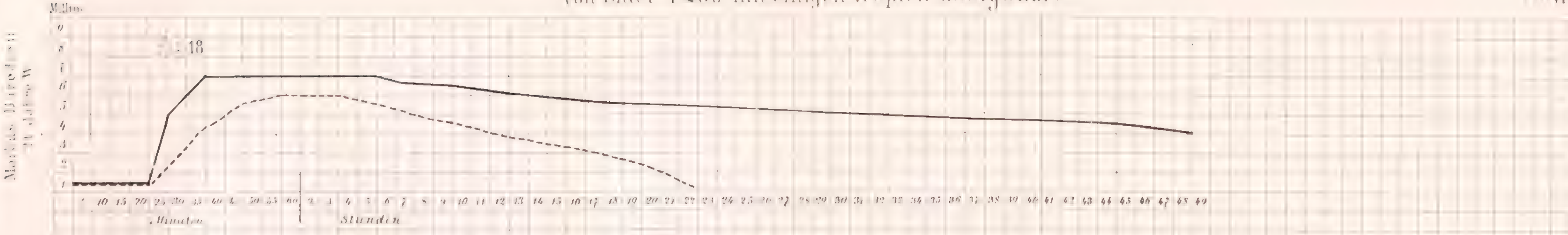
1/100 Merk amorph aus der Staatsapotheke

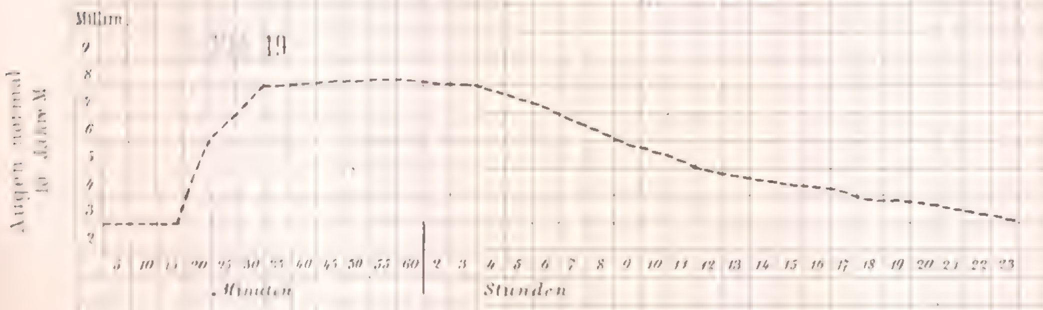


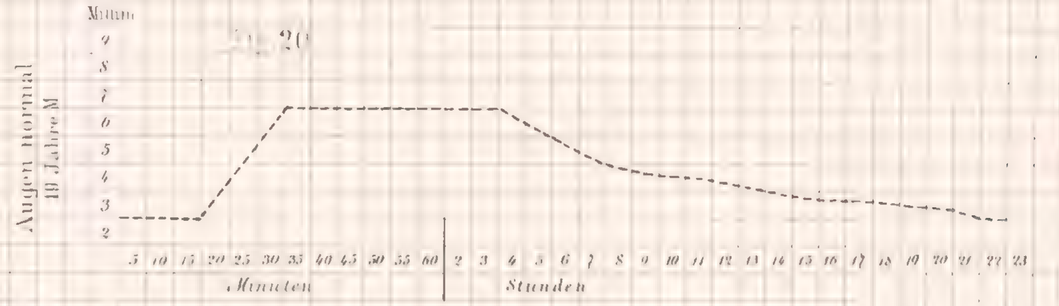
Hyoscyaminum purum

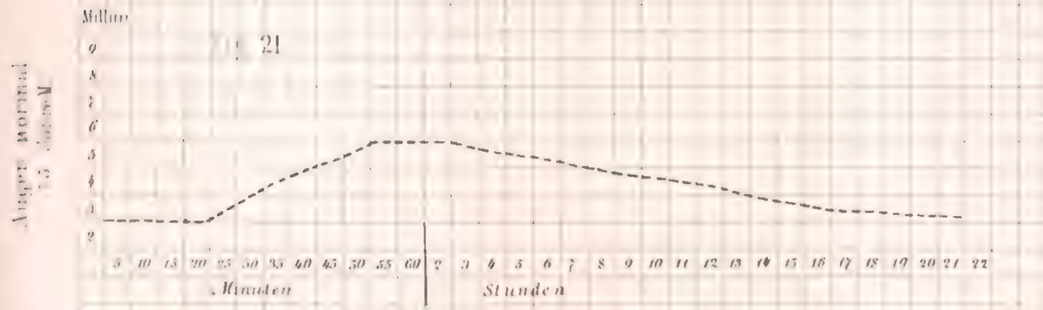
von Sittel 1:200 mit einigen Tropfen Essigsäure

Taf. VI



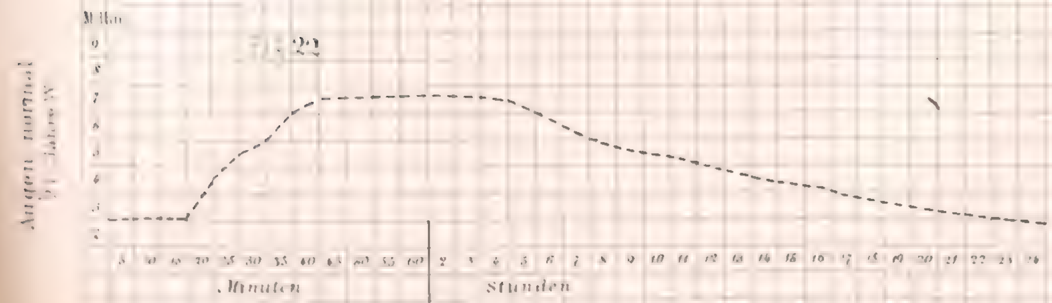


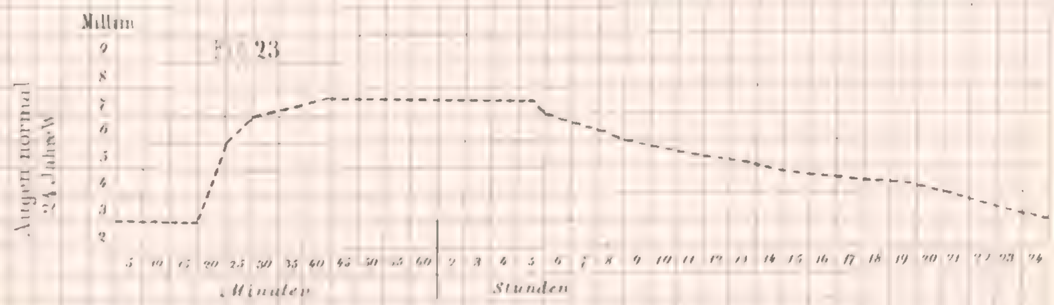




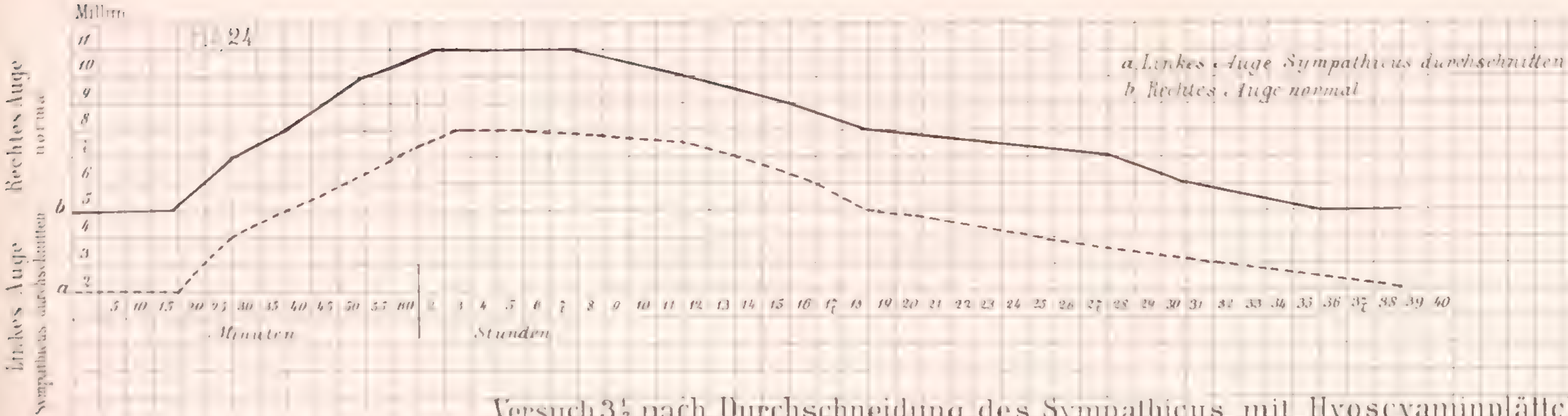
Hyoscyaminum purum

1:200 von Sittel ohne Essigsäure

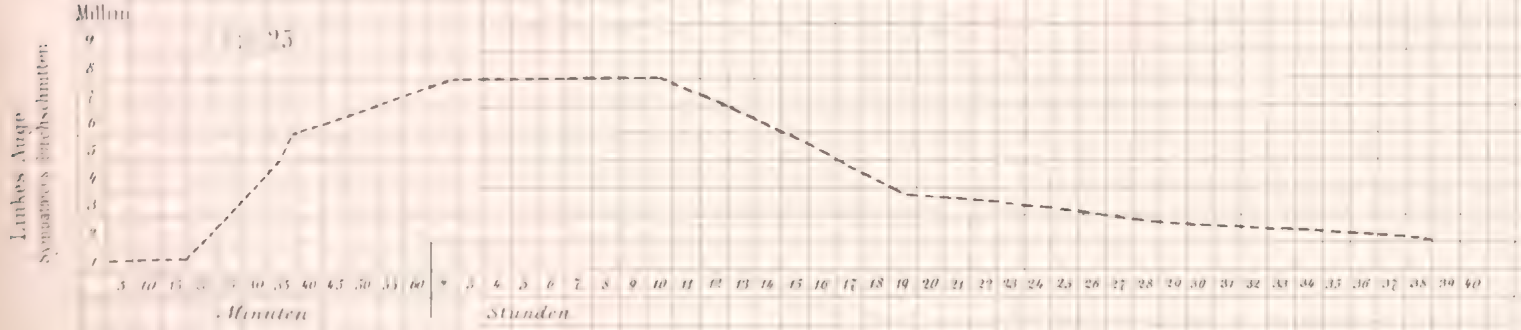


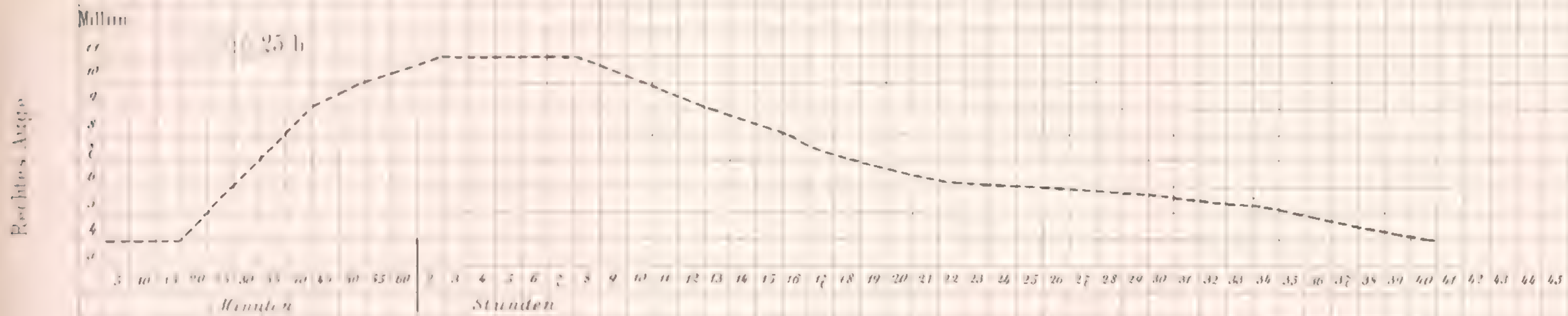


Versuch am Hund 1½ Wochen nach Durchschneidung des Sympathicus.



Versuch 3½ nach Durchschneidung des Sympathicus mit Hyoscyaminplättchen aus Turin.





Versuch 2 Monate nach Durchschneidung des Sympathicus angestellt

HYOSCYAMINE, AND ITS IMPORTANCE IN OPHTHALMOLOGY.

By ROSA SIMONOWITSCH, M.D., of Odessa, Russia.

(Translated by Dr. R. Gebser and Dr. F. A. Munson.)

[With Plates II.-VII.]

Before I speak of the results of my experiments, I will briefly give the reasons which induced me to perform them.

Atropine, as every one knows, is used very extensively in the practice of ophthalmologists; on one hand its mydriatic effect is required, as in several forms of iritis, and upon the other its influence in diminishing the intraöcular pressure, as in different forms of keratitis. A more thorough knowledge of the pathological processes in these affections and of their consequences, as well as of the physiological action of atropine, permit the conclusion *à priori*, that the use of this remedy must be beneficial, which has indeed been proved to be the fact. Pathology demonstrates that an inflammatory exudation between two surfaces which are in contact often causes lasting adhesions, and consequently, according to the functions of the organs, leads to different derangements. Similar processes and results we encounter in iritis, as the exudation of the inflamed iris leads in the beginning to slight attachments easily torn, and later to solid adhesions; the latter may be of different degrees—either slight synechiæ, or broad adhesions, or complete occlusion. Considering the physiological changes during the act of vision, we see that these adhesions must necessarily produce more or less disturbance, as the iris is unable to participate in the movements of accommodation. Besides these relatively small troubles, a continual irritation of the tissue, in consequence of the stretching of the adherent parts, is kept up, which, if long continued, may renew the inflammation; and these relapses, differing in severity, may give rise to new adhesions and other detrimental complications. In

fact, by total adhesion of the pupillary margin (exclusio pupillæ), an increase of the intraöcular pressure must take place, which may either favor the development of secondary glaucoma, or if not treated correctly, phthisis bulbi. To confirm this hypothesis it is desirable to give v. Graefe's opinion, which is well-founded on experience. After admitting that dyscratic conditions, as well as occasional disturbances, like colds, congestions, etc., may present themselves as the predisposing causes of the relapses, he points at the residua of the first affection, or at the most important element in their production.* "An iritis healed without posterior synechiæ is not generally predisposing to relapses; an iritis, with few elastic adhesions will sometimes have relapses, and one with broad and multiple synechiæ which resist repeated artificial mydriasis will, as a rule, be followed by relapses, and relapses are almost invariable if synechia posterior totalis, that is, complete exclusion of the pupil by exudation, has been established." Having related several cases from his practice to confirm this proposition, he continues: † "This fact is closely followed by another, namely, that the exclusion of the pupil is the origin of dangerous complications, particularly of chronic choroiditis, with progressive amblyopia, and finally phthisis bulbi."

These explanations prove that a continual mydriasis which prevents the contact of the iris with the lens is the most rational means of avoiding adhesions of the iris as well as their destructive consequences. These requirements can easily be met, since atropine enables us to keep the pupil widely dilated, and the pupillary margin removed from the lens, which renders adhesions impossible. The use of atropine in these cases has been indeed very appropriate.

Also in several forms of keratitis the use of atropine is of great value. We may choose as a very striking example the ulcus corneæ, where the necessity of its use can be demonstrated in the best way. The basis of the ulcus being relatively thinner than the other parts of the cornea, will resist the intraöcular pressure the least; hence the relative pressure is greatest at this

* Ueber Coreomorphosis als Mittel gegen chronische Iritis u. Iridochoroiditis, von Dr. A. v. Graefe.

† L. c., p. 210. Graefe's Arch. Band II. 2., p. 203.

point. This condition renders the nutrition of this place insufficient at a time when it is most needed on account of the repair of the loss of substance. In consequence of the disturbed nutrition and increased local pressure, mortification of tissue, with following perforation of the cornea, can easily take place. As above mentioned, we possess in atropine, as well as in the other mydriatics of the same class, remedies which are able to diminish the intraöcular pressure ; their use in these conditions is consequently justified. And in fact, in these cases, as well as in several iritides, the use of atropine has been proved very successful ; its omission very detrimental, as even the secondary affections above described are likely to occur. There are cases, however, where the use of atropine, in spite of its necessity, is contra-indicated for certain reasons. Such a contra-indication is the idiosyncrasy toward the remedy, either inherent or acquired through its constant use. In these cases the conjunctiva does not tolerate the drug ; inflammation, with pain, lachrymation, redness, swelling, and increased discharge follow its use ; the so-called atropine conjunctivitis makes its appearance. Schweigger,* in his text-book, describes it in the following manner : "We mention particularly the atropine conjunctivitis, which is very annoying in ophthalmological practice, and presents itself either in the form of a simple inflammatory swelling of the mucous membrane, with muco-purulent discharge, or in combination with swelling of the follicles of the conjunctiva ; or with slight swelling, but considerable hyperæmia and copious lachrymation. Von Graefe says : † "Any local remedy applied to the conjunctiva for a length of time produces, by its cumulative effect, an anatomical change which alters materially its therapeutical action, although we often fail to recognize it externally. An evident example of this is furnished by the now generally acknowledged saturation of the conjunctiva with atropine, of which I gave notice a long time ago (Arch. f. Ophthal., I. 2., p. 242). As soon as this condition is established every new instillation is followed by a blepharo-conjunctival irritation, with lachrymation, œdema of the lids, and even with eczematous eruptions ; and this antagonism may last for several months after the remedy has been left

* Schweigger, Handbuch der speciellen Augenheilkunde, S. 261.

† Graefe's Arch., Bd. XII., S. 200.

off. In these conditions the mucous membrane may look entirely normal. Sometimes, and usually in the more developed cases, a peculiar form of granulations, similar to the common vesicular lymph-follicles, presents itself, which can be distinguished from them only by the more consistent and yellowish contents, and by the different arrangement of the blood-vessels of the mucous membrane. There are cases, however, in which no palpable changes exist; to prove that, in some instances an apparently normal mucous membrane may be intolerant of the local application of a generally innocent remedy."

Besides these conditions, which have been so well observed and so minutely described by Von Graefe, there are, as above mentioned, other instances where the idiosyncrasy exists from the beginning, and where a single instillation produces severe lachrymation, pain, and hyperæmia; *i. e.*, an acute conjunctivitis of short duration; even erysipelas is said to have followed a single instillation in certain individuals. This form also we find described in Schweigger's Text-book (p. 261): "Differing from this atropine conjunctivitis, a very rare atropine idiosyncrasy of the conjunctiva has been described. Occasionally we meet with cases in which the instillation of one drop of atropine is immediately followed by pain and an acute erysipelatous inflammation of the conjunctiva and the lids. In mild forms of this idiosyncrasy atropine produces only a sensation of smarting and burning, besides redness of the conjunctiva."

I have found two very striking cases in the English literature, and will quote them here on account of their importance. LAWSON describes two cases where, after the use of atropine, the following phenomena appeared: * "In one of these cases, after cataract extraction, two drops of atropiæ sulfs. (gr. j. ℥ j.) instilled twice daily, caused such pain and redness as to make it necessary to discontinue the remedy. Later, atropine was instilled into the eye of the same patient, for the sake of an ophthalmological examination, and brought on severe pain, together with inflammatory symptoms, which, however, disappeared in a few days.

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* Ophthalmic Hospital Reports, 1869. On some of the anomalous effects of atropine on the eye. By George Lawson. 119.

The second case refers to a patient into whose eye a drop of atropine had likewise been instilled after cataract extraction. Immediately after, the eye became painful, the lids swollen, and on the following day an erysipelatous redness appeared, spreading over the lids and face. Lawson believed this to be accidental and not caused by the atropine, but, as it seemed to give pain, he substituted for it a solution of extract of belladonna. The erysipelas increased more and more, but disappeared in a short time after the extract of belladonna had been left off. Six months later, the same patient had atropine instilled (gr.i.—℥ i.) to dilate his pupil. Soon after, pain set in, which increased steadily, and in four hours swelling and erysipelatous redness of the skin had developed. The following morning the patient could not open his eyelids on account of the great swelling; the erysipelas had spread over his face and forehead. Atropine was discontinued, and the erysipelas, after reaching a certain intensity, diminished rapidly, and the patient recovered within a week.

The facts just mentioned prove that, under certain conditions, the atropine cannot be used, for nobody would welcome the occurrence of granular conjunctivitis. This form of atropine conjunctivitis is said to occur more frequently in the treatment of iritis than in that of other affections, which is easily explained by its long continued use for iritis; and especially in this disease the discontinuance of the atropine is followed by bad consequences, such as posterior synechia and the secondary troubles mentioned above. Another mydriatic would therefore be desirable in these cases. At first the preparation which gave rise to these conditions was believed to be impure, the salt not being sufficiently neutralized; but in many cases this was not true, as even the best preparations produced the same effects. Then an attempt was made to substitute for the salt a solution of extractum belladonnæ, which appears to me irrational if there is really an idiosyncrasy toward atropine, the latter being the active principle of the extract of belladonna. It would have been better in such cases to discard belladonna and its compounds altogether, and to substitute other preparations of a similar physiological action. Fortunately we have hyoscyamine and daturine, whose mydriatic effects have long been known, but have

not largely been turned to account, first, because the action of these remedies was variable; and secondly, because the general use of atropine had caused their neglect. From these reasons, I think the effort to introduce another mydriatic into ophthalmology is quite justified, and the preparation of such a remedy will not only enrich the pharmacy, but be of real practical value. I therefore acceded gladly to the proposition of Prof. DOR to study the action of hyoscyamine upon the pupil, and its application in ophthalmology, and I am under obligations to him for those suggestions as well as for his kindness in advising me whenever I needed assistance. Besides these merely practical reasons, there was another one which rendered experiments with hyoscyamine desirable, namely: because in literature there is a lack of information in regard to it. While we have a series of experiments with atropine, explaining chiefly its relation to the eye, which are published in several works and dissertations, the same cannot be said of hyoscyamine. Even DONDERS, who experimented with the different mydriatics and myotics, says but little about hyoscyamine. In KUYPER'S dissertation, who wrote under his guidance, we find experiments with all substances of mydriatic action, but with hyoscyamine he made only few experiments, using merely the aqueous and alcoholic extracts, the alkaloids not being at hand. It being desirable to learn more extensively the physiological action of hyoscyamine, I made several physiological experiments with that object in view.

HISTORICAL REMARKS.

The ancients are said to have known and used henbane. HIPPOCRATES recommended it for different kinds of neuralgia. DIOSCORIDES * knew its physiological action, and employed it as a remedy for different forms of neuralgia; also in the treatment of eye diseases it was applied as a poultice. †

In the middle ages its therapeutic value was neglected; it was used only for other purposes, for instance, to create fantastic dreams.

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* Liv. i., c. xxxv. † Liv. iv., c. lix.

In the sixteenth century again, MATHEWS * mentions its value for certain diseases, spermatorrhœa, menorrhagia, etc.

In the eighteenth century frequent experiments were made with different solanaceæ, among them, with henbane, by WEDEL, ROSEN, SLEVOGT, HOOK, and GREDING. GREDING,† well acquainted with its properties, advised against its use on account of the possibility of dangerous complications following its employment. Later experiments regarding the use of these remedies were more frequent, and we find in the journal of Leroux and Corvisart ‡ a series of articles by MEYLIN, and in Hufeland's § journal, by BREITING, who used it for neuralgia.

FOUQUIER and RATIER ‖ made therapeutical experiments with hyoscyamus.

In 1820, BRANDES ¶ found the alkaloid of hyoscyamus, and called it hyoscyamine.

In 1824, RUNGE ** draws attention to the mydriatic action of hyoscyamine as a means to detect the smallest quantities in cases of poisoning by the Solanum family; experiments with rabbits demonstrated that these alkaloids are rapidly transferred to the secretions and excretions of the body. After three days feeding with these plants, the urine of these animals always possessed a mydriatic action.

In 1826, REISINGER †† made physiological experiments with hyoscyamine in cats; he observed invariably dilatation of the pupils.

In 1833,‡‡ GEIGER and HESSE prepared chemically pure hyoscyamine in form of crystals.

In 1847, FLORENT CUNIER §§ experimented with hyoscyamine,

* Annot. Liv. i., c. xxxv.

† De extracto hyoscyami viribus et efficacia, praesertim in melancholisis et epileptisis morbis. Par J. Em. Greding, in adversaria medico-practica, etc., de Ludwig, T. i., p. 71.

‡ T. xxii., xxiii., xxvii., xxxii.

§ T. xxv., D. 149.

‖ Archives de Médecine, T. i., p. 207.

¶ Journal de Pharmacie, T. vi., p. 530.

** Journal de Pharmacie, 1828, p. 24.

†† Archives de Médecine, T. xviii., p. 300, Extract de "Medical and Chirurgical Journal," 1828, Feb. 5.

‡‡ Annales de Chimie et de Physique, T. vii.

§§ Annales d'Oculistique, publiées par le Docteur Florent Cunier, T. xvii., 1847.

daturine, and atropine, and described the physiological action of the two first ones in the following manner: "Leur effet mydriatique est aussi prompt que celui de l'atropine, mais celui de l'hyoscyamine est beaucoup moins persistant." He recommends them on account of their speedy and transient action in examination of the lens.

In 1855,* SCHROFF made experiments with several kinds of extracts of hyoscyamus. He used aqueous and alcoholic extracts of the fresh herb, and of the root of a one-year-old plant. The main results of his experiments are as follows: Small as well as large doses reduced the frequency of the pulse, but after large doses an accelerated pulsation follows the slackening. Large doses administered internally and externally produce dilatation of the pupils, dullness in the head, dryness of the lips, mouth, and throat, diminution of saliva, and fatigue; still larger doses produce stupefaction with great inclination to sleep; and very large quantities even cause coma. The other phenomena were deep, sound sleep, sometimes interrupted by alarming dreams, frequently headaches, and nearly always dizziness, tinnitus aurium, weakness of sight, so that letters could scarcely be distinguished, increased sensibility of the eye toward light, diminished sense of smell, and the impossibility to look steadily at objects. In regard to the quantitative difference between hyoscyamine and daturine, the first appeared at the time to have the weakest effect, the daturine the strongest; and the action upon the pupil was not particularly observed.

In the year 1856 SCHROFF published his experiments made with Merk's hyoscyamine, which had been prepared in the same year. These experiments are of much more importance than the first ones, as a great deal more attention was paid to the action of hyoscyamine on the pupil. Merk's hyoscyamine is not crystalline, but an amorphous, brown, sticky mass, soluble in alcohol and water. Experiments with this preparation gave the following results: Its general action was the same as in previous ex-

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* Separat-Abdruck aus dem Wochenblatt der k. k. Gesellshaft der Aerzte in Wien, 1855, Ueber Hyoscyamin und die aus ihm dargestellten Extracte der neuen österr. Pharmacopöe von Prof. Dr. K. D. Schroff.

† Separat-Abdruck aus dem Wochenblatt der k. k. Gesellschaft der Aerzte in Wien, 1856. Ueber Hyoscyamin von Prof. K. D. Schroff.

periments, so that a repetition would be superfluous. In regard to its action on the pupil, his results differ from those of Cunier, and others, which we will mention later. Schroff is of the opinion that Merk's hyoscyamine affects the iris more intensely than atropine; $\frac{1}{2000}$ gr. put into the human eye is, as he says, enough to show its effects after 3 minutes, while an equal dose of atropine has the same result only after 15 to 20 minutes; moreover, by hyoscyamine the maximum dilatation of the pupil was produced earlier and continued longer than by atropine. It lasted three days; on the fourth the contraction commenced, but the normal size was not yet restored on the seventh day, whereas after the use of atropine the contraction commenced already on the second day, and on the fourth the pupil was of normal size. Even one drop of a solution $\frac{1}{60}$ gr. : ℥i. water brought on a perceptible dilatation of the pupil, which lasted for 5 to 6 hours, the same solution of atropine being inefficient. The reduction of the range of accommodation as well as diminution of sight were more intense after hyoscyamine, and lasted longer. A solution capable of producing a sufficient dilatation should be composed of one part of hyoscyamine to 1,000 parts of water (gr. ½ ad aq. ℥i.) with the addition of 10 parts of alcohol to preserve it for a longer time.

1859.* KUYPER made experiments concerning the artificial dilatation of the pupil with different mydriatics, and also with hyoscyamine. He published his results afterwards in his dissertation. Not having the hyoscyamine at his disposal, he experimented with the aqueous and alcoholic extracts of hyoscyamus. We will report here only the results of his experiments on the human eye. A solution of 1 : 6 of the aqueous extract produced a dilatation of 5–6, 9 mm. within 20 minutes. On the following morning the pupil had nearly the same size as in the normal fellow eye.

A solution of 1 : 120 gave perceptible dilatation after one hour. The pupil had dilated from 2½ mm. to 5⅓ mm., and was normal on the next day. The experiment with the alcoholic extract 1 : 6 showed that the dilatation of the pupil commenced 18 minutes after the instillation, increased gradually during three

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* Onderzoekingen betrekkelijk de kunstmatige Verwijding van den Oogappel. Arnoldus Hermanus Kuyper.

hours to the diameter of 7.5 mm. The next day there was perceptible difference in the size of the pupils, which on the third day had not entirely disappeared.

By a solution of 1 : 120 the dilatation was perceptible after 35 to 55 minutes, increased for 1 to 2 hours, and then receded. On the second day only a slight difference in the size of the pupils was observed.

In 1865 we find reports on the therapeutic use of hyoscyamine by Fronmüller.* He administered it in 53 cases, but did not observe the secondary effects upon the eyes.

In the same year Lematre† published his experiments concerning the physiological effect of hyoscyamine. In regard to the general action it was not exactly the same as in Schroff's experiments; he usually noticed an increased pulsation, but no previous diminution, at least we do not find its mention in his work. The other symptoms were increased frequency of respiration, change of blood pressure, lowering of the temperature, dryness of mouth and throat, vomiting not constant, dysuria, paralysis of the bladder, diminished sensibility, sometimes preceded by hyperæsthesia, derangement of co-ordinate movements, sometimes convulsions and paralysis, and marked death rigor. I will mention somewhat more at length the action of the pupil, as the results obtained by Lematre in regard to the quantitative effect differ from those of Schroff. Parallel experiments with the three alkaloids gave the following results: ‡

(*a.*) Sur l'œil gauche d'un chien je laisse tomber quelques gouttes d'une solution de sulfate d'atropine; au 10^{c} au bout de trois minutes dilatation dans l'œil gauche, au bout de cinq minutes dilatation dans l'œil droit.

(*b.*) Sur l'œil gauche d'un autre chien je laisse tomber trois gouttes d'une solution de daturine au 10^{c} au bout de quatre ou cinq minutes mydriase à gauche; au bout de six ou sept minutes mydriase à droite.

(*c.*) Sur l'œil gauche d'un troisième chien je laisse tomber quelques gouttes d'une solution de sulfate d'hyoscyamine au même

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* Deutsche Klinik, 1865.

† Archives générales de médecine, Juillet, Août, 1865.

‡ Archives générales, pag. 53.

titre : au bout de dix minutes, dilatation à gauche ; au bout de quinze minutes dilatation à droite.

Weaker solutions produced the same results in proportion to the different strength of those three experiments of solanum, consequently these experiments proved atropine to be the strongest, daturine next, and hyoscyamine the weakest.

In 1867 Schroff read a paper before the Royal Imperial Society of Physicians in Vienna (December 6th, 1867) about his new experiments relating to the effect of hyoscyamine on the pupil, which confirmed the results published in 1856. He had been induced to repeat his experiments by the observations of Ruete, who had arrived at different conclusions in regard to the action of hyoscyamine on the pupil, as it appeared to the latter plainly that it was a great deal less powerful than a solution of atropine of the same strength. Ruete* experimented with the crystalline sulphuric hyoscyamine prepared after Geiger's method.

A rabbit, whose pupil measured 5½ mm. in diameter, received a drop of a solution of hyoscyamine, ½ gr. : ℥ ss. aq., after 20 minutes the pupil dilated to 6 mm., after 30 minutes to 7½ mm., after 45 minutes to 8 mm. ; within 44 hours both pupils were equally dilated, and measuring 5 mm. in diameter. An equally strong solution of atrop. sulf., used upon a rabbit, whose pupil was 6½ mm. in diameter, showed its effect so soon as 5 minutes ; after 7 minutes the pupil dilated to 8½ mm. ; at 30 minutes to 9¾ mm. ; after 44 hours it measured 6¼ mm., the pupil on the unatropinised eye was at the same time 5½ mm.

Schroff†, therefore, repeated the experiments, but had the same results as at the first time, finding that hyoscyamine acted more internally than atropine. He made 20 experiments with Merk's amorphoushyoscyamine, prepared at different times, used stronger and weaker solutions, and hyoscyamine which had been exposed to the air for some time, as it had been asserted that under such conditions its efficacy was altered. The result was that a solution of hyoscyamine (1 : 2100) made the pupil dilate

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* Repertorium für Pharmacie, herausgegeben von Dr. L. Buchner, 16 Band, 8 Heft, S. 502–509.

† Separatabdruck aus No. 1 des Wochenblattes der k. k. Gesellschaft der Aerzte in Wien, Ueber Mydriatica im Allgemeinen und über das Verhältniss des Hyoscyamins zum Atropin insbesondere.

after 5 minutes, the maximum of 9 to 12 mm. was reached in 30 minutes ; lasted 6 to 7 hours, and 29 hours later the pupil had its normal size again.

Atropine solutions of equal strength produced dilatation not before 10 minutes ; reached the maximum, which was the same as after instillations of hyoscyamine after 40 to 45. This condition lasted about 6 hours, then the pupil commenced to contract ; 24 hours later it showed its normal size.

The weaker solutions of hyoscyamine (1 : 2100) made the dilatation perceptible after 15 minutes ; produced the maximum of dilatation of 1 to 2 hours duration after 40 minutes ; then gradual diminution till 5 to 6 hours later the usual size of the pupil was re-established. Atropine solutions of equal strength did not alter the size of the pupil in the least.

In 1870 Laurent* published his physiological studies on hyoscyamine, and its therapeutical use. He observed likewise an acceleration of the pulse, combined with increased blood pressure after small doses ; large doses caused the same acceleration, but decrease of blood-pressure. Direct application to the skin, as well as subcutaneously, made the small vessels contract. According to his experiments, the involuntary muscles were not influenced by hyoscyamine, except the heart-muscle, whose activity was diminished. In regard to the smooth muscles, small doses produced contractions, large ones paralysis.

His experiments relative to its action on the pupil resulted as follows :

Injections of hyoscyamine into the anterior chamber of extirpated rabbit eyes did not alter the size of the pupil. After excising the superior cervical ganglion, injections of hyoscyamine into the subcutaneous cellular tissue of the thigh produced dilatation of the pupil in the eye on the side which had not been injured, while on the operated side a very slight dilatation appeared after 15 minutes, reaching only ⅓ of the size of the pupil of the other eye.

If hyoscyamine is instilled before the division of the sympathetic nerve, the pupil will contract after the operation, and dilate if the sympathetic nerve is irritated. The severing of the

* De l'Hyoscyamine et de la Daturine, études physiologiques. Applications thérapeutiques, par C. D. Ch. Laurent.

nervus opticus and trigeminus does not alter this phenomenon. Upon irritation of the oculomotor nerve, after previous instillation of hyoscyamine, the pupil contracts, and dilates as soon as the irritation ceases. After dividing the oculomotor nerve the instillation of hyoscyamine makes the iris nearly disappear.

Therefore, Laurent, on the strength of his experiments, seems to favor the supposition that the mydriatic action of hyoscyamine is due to the irritation of the dilator of the pupil by means of the sympathetic nerve, and that the oculomotor nerve does not participate in this action.

The last work * on hyoscyamine relates more to its derivatives, the hyoscyn and hyoscynic acid. Considering the hyoscyamine proper it showed the following effect: "Acceleration of the pulse, diminished irritability of the motor nerves, as well as of the reflex irritability, slower respiration, which at the same time appeared to be deeper. The action on the pupil commenced just as early, and was of the same intensity as when atropine was employed." Hellmann made his experiments with crystallized hyoscyamine.

The hyoscyn and the hyoscynic acid, if prepared perfectly pure, did not act on the pupil at all.

Thus the literature demonstrates that the opinions in regard to the quantitative action of hyoscyamine, compared with that of atropine, differ very considerably, while Cunier, Lematre, Ruete, and Laurent believe the hyoscyamine to be the weaker of the two ; Hellmann asserts in his dissertation that both mydriatics have the same power. Schroff attributes to hyoscyamine the greater strength. These differences of the results of the experiments of different investigators can only be explained by the use of preparations of variable power. Errors of observation could not possibly happen since the experiments are very simple. As above mentioned, the different intensity of the effect must therefore be sought for in the difference of the employed preparations, and these preparations have indeed been obtained in various ways. While the hyoscyamine of Hesse and Geiger † appears in solid,

* Beiträge zur Kentniss der physiologischen Wirkungen des Hyoscyamins und der Spaltungsproducte des Hyoscyamins und Atropins. Inaugural-Dissertation von Dr. Moriz Hellmann, Jena, 1873.

† Ann. Chem. Pharm, vii., 290.

fasciculated, silky transparent needles, that of other chemists, as of Kemper and Ludwig*, Wagdymar †, Thorey ‡, Kletzinsky §, is prepared in crystalline form, in shape of white, shining needles or bundles. Renar and Dragendorf ‖ manufacture it always in the form of a brown amorphous substance.

Consequently there is no doubt that the results must differ according to the use of amorphous or of crystalline hyoscyamine. Experiments with the former will likewise give different results, as the composition of the amorphous preparations is probably not uniform ; and, in fact, it is known that the different experimenters, Hellmann excepted, employed the amorphous hyoscyamine. It is obvious that the use of this form yielded in one series of cases a more intense action, in another a weaker, according to the smaller or larger addition of non-mydriatic substances. To arrive at positive conclusions concerning the quantitative effect of hyoscyamine, a preparation has to be employed which is of a constant composition, and this can only be expected from the crystalline hyoscyamine, if the crystals are of the same form. Merk** asserts that he has obtained another pure form of hyoscyamine by means of distilling it in a stream of hydrogen. Pure hyoscyamine is said to form crystalline salts only with oxalic and nitric acids, but not with other acids, such as sulphuric and acetic, with which they say the crystalline hyoscyamine usually combines. To arrive at positive facts in regard to the quantitative action of the hyoscyamine, it would be necessary first to test the pure preparation, that is, the crystalline form as obtained by Merk's method, and then, for the sake of comparison, with the results of other experimenters, also the amorphous preparations. But as we did not possess the first we commenced our experiments with different kinds of the amorphous hyoscyamine, waiting for the crystalline and Merk's hyoscyamines. The following amorphous preparations were at our disposal: Amorphous, 1. Hyoscyamine from

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* Archiv. Pharm., clxxvii., 102.

† Proceed. Amer. Pharm. Association, 1867, 404.

‡ Pharm. Zeitschrift Russlands, Juni, Juli, 1869, auch Schweiz. Wochenschrift für Pharm., 1869, 264.

§ Schweiz. Wochenschrift f. Pharm., 1866, 85.

‖ Pharm. Zeitschrift für Russland, vi., 595.

** Jahresbericht, 1870, S. 353, und S. 871, S. 290.

Morson & Co., London, which was in possession of Prof. Dor since 1870; 2. the hyoscyamine plates prepared in the laboratory of the ospedale oftalmico, Turin; 3. Merk's amorphous hyoscyamine from the state pharmacy in Bern.

The first experiments we made with the London hyoscyamine. It appeared as a dark-brown substance, of the consistence of a thick extract, was very impure, and left in alcohol a dark-brown mass similar to the extract. The evaporated alcoholic solution, neutralized by soda and shaken with chloroform, left a light yellowish residuum, insoluble in pure water, but easily soluble in acidified water, alcohol, and chloroform. Prof. Dor asked the druggist, Mr. Perrenoud, to prepare some solutions of this form, one solution of pure hyoscyamine, 1 : 500, two of acetic acid, and two of sulphuric acid. Of each salt a solution of 1 : 500 and one of 1 : 200 aq. were made. The acetified solution appeared as a dark-brown mass, of the consistency of syrups, the one with sulphuric acid was lighter, but harder. All these solutions were clear, of brownish color, which, of course, appeared lighter in weaker solutions. With the pure hyoscyamine we experimented several times, but observed either no effect or a very weak one. Only in one case dilatation followed, which might have been represented by a curve, but it happened only after a second instillation two hours later.

Case I.—After the first drop, as in the previous cases, no dilatation was perceptible. In fig. 1, Tab. ii., the curve of this dilatation is shown. The dilatation commenced twenty-five minutes after the instillation, reached the maximum only at the second hour, being 7 mm. in diameter. Original size 3 mm., absolute dilatation 4 mm. The maximum continued only three hours, and the pupil reacted the whole time upon light and accommodation. During the first hour of the maximum enlargement the pupil moved somewhat slowly, the accommodation was slightly affected. The usual use of the eye could be continued without fatigue. At the last measurement, ten hours after the instillation, the pupil had a diameter of 4 mm., and on the following day its size was normal.

The second series of experiments were made with sulphuric hyoscyamine, the acetified preparation was only employed in pathological cases. I first tested a weak solution of 1 : 500. I made in these cases comparative experiments with atropine sulf. in similar concentration, using hyoscyamine upon the one eye, and atropine on the other. In figs. 2 and 3, Tab. ii. the curves illustrating these experiments are drawn, the small lines represent the hyoscyamine, the dark ones the atropine curves.

CASE II.—In the first case (fig. 2) the dilatation began in both eyes fifteen minutes after the instillation. After twenty minutes the diameter of the pupil of the eye into which atropine had been dropped, was increased ½ mm. as was also that into which hyoscyamine had been applied ; both were at first alike. The maximum enlargement of 9 mm. was attained in the first eye after thirty minutes, and in the second of 8 mm., after forty minutes. This amount of dilatation continued in both eyes for five hours, at the end of which time contraction began. Twelve hours after the application the pupil of the first eye had a width of 7 mm., that of the second of 4 mm., and in thirty hours the pupil of the first had returned to its natural size, whereas that into which atropine had been instilled, returned to its normal condition only after fifty-seven hours. The accommodation of both eyes suffered nearly alike. After 40 minutes the patient could no longer thread a needle, and reading became very difficult. In fifty minutes the near point was at 7″ which was usually at 4″, a half hour later and the punct. prox. was removed to 7½″, and the punct. remot. remained at 16″ distance.

CASE III.—In the second case (fig. 3) the dilatation from hyoscyamine began in fifteen minutes, and reached a maximum of 8 mm. in forty-minutes, after remaining at this height for four hours, contraction commenced, and in twelve hours the pupil had a width of 4 mm., and on the following morning its natural size. In the eye into which atropine had been dropped dilatation likewise began after fifteen minutes, and the maximum (9 mm.) was attained in forty minutes, and continued for four hours. After ten hours the pupil had a diameter of 7 mm., and contracted to its original size in fifty-six hours. The accommodation of both eyes was affected alike, the near point being removed from 2″–3″ the far point, — with a myopia of one-fifth—remained at 5″ distance. The three first experiments were made on young people with normal eyes, on older persons the action of atropine of this strength is less vigorous, and the hyoscyamine is still weaker, dilatation being hardly perceptible upon its application, and requiring much more time. Therefore I made a solution of 1 : 200 and another of atropine of equal strength.

CASE IV.—In this instance (fig. 4), the patient being a man sixty-one years of age, with double cataract, the dilatation began in the eye into which hyoscyamine had been instilled in twenty minutes, the maximum of 7 mm. was reached in two hours and a half. The original diameter of the pupil was 2 mm. The mydriasis continued at its height for four hours, after which contraction commenced, and in thirty-six hours the pupil was of natural size.

The action of the atropine which had been dropped into the other eye

at the same time was as follows : The greatest enlargement, also 7 mm., was reached in one hour and twenty minutes, and lasted six hours, then narrowing began, but after forty-eight hours the pupil had not yet returned to its normal diameter.

In two other cases the observations could not be followed to a termination ; in one instance the patient left the clinic, so that I possessed only the ascending curve ; in the other, an operation was made on the following day, so that I only had an opportunity to measure it once—the descending curve is consequently incomplete.

CASE V. (Fig 5.)—Dilatation commenced in the eye into which hyoscyamine had been instilled after 15 minutes. The maximum (6 mm.) was attained in one hour and fifteen minutes. In the eye into which atropine had been dropped dilatation likewise occurred after 15 minutes, but the maximum (7 mm.) was reached in 65 minutes.

CASE VI.—In the last case (Fig. 6) the enlargement from hyoscyamine also took place after 15 minutes. The maximum (7 mm.) was arrived at in 45 minutes and continued 4 hours ; after 10 hours the pupil had a width of 5 mm., and on the subsequent day, nearly 23 hours after the instillation, a diameter of 3½ mm. The dilatation in the atropinized eye commenced together with the first, but the greatest size was already reached in 35 minutes and persisted nearly 4 hours. After 23 hours the pupil had a width of 5 mm.

From this series of experiments it is shown that the action of hyoscyamine is much weaker and less continuous than atropine. Besides, its instillation is accompanied by a burning pain which lasts from 10 to 15 minutes.

The second series of experiments I made with gelatine disks of hyoscyamine and atropine, prepared in Turin. Being unaware of the quantitative composition of these disks it was necessary, if possible, to ascertain the same, hence Prof. Dor wrote to Mr. Sperino in Turin concerning their composition, upon which the following answer was received :

"J'ai interrogé le Pharmacien de l'hôpital à propos des demandes que vous m'avez fait l'honneur de m'adresser ; il m'a répondu que l'hyoscyamine provient des magasins de Mr. Heberlein de Milan, et qu'elle est sous la forme d'extrait. Quand à la dose de chaque disque, il m'a dit qu'il ne peut la faire connaître par ce que la fabrication de ces disques est sa spécialité, mais qu'il peut dans certaines limites fabriquer ces disques avec les doses fixées par les médecins eux-mêmes."

In consequence of this answer, which gave us no information respecting the composition of these disks, wecould arrive at no positive conclusions concerning the *rclative* action of hyoscyamine compared with atropine. Nevertheless it was interesting to become acquainted with and compare the *absolute* action of the one with the other, as in commerce they always have the same quantitative composition. The results of these tests are represented in the series of curves.

Cases VII., VIII., and IX.—In these three cases (Figs. 7, 8, 9) the enlargement of the pupil commenced 15 minutes after the introduction of the disks. and reached in the first case a maximum (9 mm.) in 45 minutes, in the second ($8\frac{1}{2}$ mm.) in 30 minutes and in the third case (8 mm.) even as soon as 25 minutes. In these three instances the dilatation remained at its height for 18 to 20 hours, then contraction began, which was complete only on the fifth day. The accommodation was reduced in each case. There was also clearly pronounced micropsia as the individuals were able to make distinct observations. The disturbance of vision was very annoying.

Case X.—In this experiment, upon a man 60 years of age, the dilatation began in 25 minutes and attained its greatest extent (6 mm.) in one hour, it remained at this point 18 hours, and by the fourth day the pupil had returned to its natural size.

Case XI.—Upon a girl of 19 years, who had old maculæ corneæ, a high degree of myopia, with staphyloma posticum and greatly diminished acuteness of vision, the mydriasis commenced after 20 minutes, and in one hour had reached its height (6 mm.), in which condition it continued nearly 20 hours before contraction began. On the third day there still existed a scarcely perceptible difference in the diameter of the pupils.

As compared with the hyoscyamine disks those of atropine exhibited some variation in the beginning and ending of their action, as may be clearly seen in the curves of 6 and 7. The ascending and also the descending curves are less steep, the maximum is of a smaller degree, and when one considers the absolute dilatation it shows a weaker intensity of action.

In the last two cases a disk of hyoscyamine was placed in one eye, and another of atropine in the other eye, for the purpose of a more accurate comparison.

CASE XII.—In Fig. 12 two such curves are represented. The pupil of the eye into which hyoscyamine had been introduced was at the beginning of the experiment $\frac{1}{2}$ mm. smaller than that of the eye into which atropine was placed. Yet after 35 minutes the pupil of the former was nearly 1 mm. wider than that of the latter. The greatest amount of dilatation was reached in 50 minutes, being in the first (from hyoscyamine) 9 mm. and in the second (from atropine) 8 mm. The difference in intensity was therefore $1\frac{1}{2}$ mm. The normal diameter of the pupil was attained in the first after 4 days, while in the second it was not yet reached on the 5th day.

CASE XIII.—In the last case the size of the pupil of the eye into which atropine was placed was also greater than its fellow by 1 mm. Dilatation began in 15 minutes, and the maximum enlargement, which was alike in both eyes (8.5 mm.), was reached in the atropinized eye in 40 minutes, and in the other in 50 minutes. The original difference was therefore compensated, the pupils being now of the same diameter; hence the action of the hyoscyamine was 1 mm. the strongest. The mydriasis continued nearly 8 hours, the normal of the pupil under the influence of hyoscyamine was attained in 4 days, and of the other, effected by atropine, in 5 days.

The third series of experiments I made with Merk's hyoscyamine, prepared by the city apothecary of Bern. The earlier experiments of Dr. CHOPART, a deceased assistant of Prof. Dor, were made with this preparation, and the results of his investigations, which were communicated to me by Prof. Dor, I will briefly cite. He employed a solution of 1 : 500.

In the first instance enlargement began in 15 minutes, and reached its maximum (6 mm.) in 25 minutes (natural width, 3 mm.). It remained at this height for some time; but in the second hour a repeated increase of dilatation took place, whereby the pupil attained a diameter of 7 mm.; consequently, the absolute amount of dilatation was 4 mm.

In another case mydriasis began in 20 minutes, and in one hour the width of 7 mm. was reached. The original size being 5 mm., the absolute amount of enlargement was only 2 mm.

In a third case, where the dilatation commenced after 20 minutes, the maximum size was attained in 30 minutes, it was 6 mm. The normal diameter being 4 mm., the absolute dilatation was consequently 2 mm.

In the fourth instance mydriasis began in 25 minutes, and after 35 minutes the pupil was 7 mm. wide, in which condition it remained until

after 1 hour and 40 minutes, when it increased 1 mm. (8 mm.). Primary width being 2 mm., the enlargement equalled 6 mm.

Dilatation commenced in the fifth case after 35 minutes, and the maximum (7½ mm.) was reached in 55 minutes. The natural diameter of the pupil being 5 mm., the increase in size was consequently 2½ mm.

Pure atropine of equal strength worked somewhat slower, its action beginning after several instillations, and the maximum effect being attained much later.

Therefore, on the whole, the action of a solution of this concentration is not very powerful; but viewed in comparison with our own results from the same preparations, it is very energetic.

I made twelve experiments with it in a solution of 1 : 100. In eight cases I obtained almost negative results. In three of these eight I received an entirely minimum dilatation, which did not begin until after two hours; and in the other five instances no effect whatever was observed. The remaining four cases, in which a perceptible enlargement was seen, I will here mention:—

Case XIV.—Dilatation began in 30 minutes after the instillation (Fig. 14), and reached its maximum (8 mm.) in 60 minutes. The original diameter was 3 mm., therefore the absolute increase was 5 mm. The following morning the pupil had regained its normal size. It reacted the entire time upon the stimulus of light and accommodation; but its movements were very sluggish when the effect was greatest.

Case XV.—In the second case (Fig. 15) the enlargement commenced in 45 minutes, and attained its height (5 mm.) in one hour. Original diameter was 2 mm, hence the extent of absolute dilatation was 3 mm. The next day the pupil possessed its natural size. Its reaction was evident throughout, as in the preceding instance.

Case XVI.—Dilatation occurred after 25 minutes, and reached its maximum (7 mm.) in 2½ hours. The normal size (4 to 5 mm.) was regained on the following day. The pupil responded just as strongly to light and accommodative efforts as that of the other eye, into which nothing had been placed.

Case XVII.—In the last case mydriasis began after one hour and a quarter, and was at its height (6 mm.) in 3½ hours. The natural diameter being 3 mm., the absolute enlargement was of the same amount (3 mm.). Here also the pupil responded the entire time to light and accommodation.

The fourth series of experiments was with the hyoscyamine prepared after the method of Merk, distilled in a stream of hydrogen. It was nearly colorless, perfectly fluid, and appeared like the liquid alkaloids, coniine, nicotine, etc.* Its reaction was alkaline, and it formed a flocculent precipitate with acids. Saturated with oxalic acid, it was neutral at first; but after drying over sulphuric acid, by which process fine crystals were deposited, its reaction became acid. These crystals are probably either pure oxalic acid, or an acid salt of hyoscyamine. Before it was attempted to form crystals, I made a few experiments with an aqueous solution.

I first tried a solution of pure hyoscyamine and one of acetic hyoscyamine in a strength of 1 : 500 of water. I made five experiments with each solution. Among these ten cases only once was dilatation obtained, upon the eye of a young girl, 19 years of age, and the absolute enlargement was but 2 mm., which continued only for a short time. After eight days the same solution was again instilled into the eye of this patient, but this time without any effect whatever. Being dissatisfied with the results derived from this concentration, I employed a stronger solution, namely, 1 : 100, but the results were the same. Not once in eight cases was mydriasis observed. I did not continue the experiments with this preparation, as it was found that it did not produce crystals with oxalic acid.

As it was necessary to compare the action of the hyoscyamine crystals with atropine, we endeavored to procure this form. Hearing from Prof. VALENTINE that SITTEL in Heidelberg possessed it, Prof. Dor wrote to him; but having at the time no crystals, he sent the amorphous hyoscyamine, the action of which, as compared with the crystals, he praised very highly in his letter. This form was also prepared, after Merk's method, in a stream of hydrogen. It was a dark-brown, syrup like, heavy mass, soluble with difficulty in water, but easily so in acidified water, alcohol, and chloroform. The watery solution was cloudy, and exhibited an abundant sediment; after the addition of a drop of acetic acid it became less cloudy, but still not perfectly clear. We made seven trials with this hyoscyamine in a strength of

* The preparation is from Merk's Laboratory.

1 : 200, from which we found that its action was moderately intense, and not long-continuing. This quality is of great importance for certain purposes. For instance: for an ophthalmoscopic examination one is enabled to obtain considerable dilatation without the unpleasantness of the long-continued mydriasis which follows the instillation of atropine. Figs. 17–23 represent the curves made by experiments with this hyoscyamine. Figs. 17, 18, 19 and 20 are tests with the solution to which a drop of acetic acid had been added. Figs. 21, 22 and 23 are made with the dark-colored solution.

The application was always accompanied by a good deal of pain, which lasted, with decreasing intensity, nearly twenty minutes.

The experiments with the hyoscyamine, to which a few drops of acid were added, were on individuals of varying ages; hence the difference in the ascent and continuance of the curves.

Case XVIII.—The test was upon a female patient who suffered from morbus Basedowii, whereby the interesting fact was discovered that the action upon this patient commenced later than upon others, and also that the ascending curve exhibited a less steep course, which was, perhaps, in confirmation of the theory that in this disease there is an affection of the sympathetic nerve. The original size of the pupil was very small, even somewhat narrower than it is in a dog upon which the sympathetic of one side has been divided, and whose pupil shows only a width of 2 mm. by direct illumination. In this case, under similar conditions, the pupil was only 1½ mm.

In Fig. 18 are represented the hyoscyamine curves (small) and the atropine curves (large). In the eye into which hyoscyamine was instilled dilatation commenced after 20 minutes; whereas, in all other instances it began in 15 minutes. The maximum (6 mm.) was reached in 55 minutes, and continued nearly three hours; but on the following morning its effects had completely disappeared. This was true in all the cases. Atropine of similar strength exhibited a much more intense action. Mydriasis also began after 20 minutes; but the maximum enlargement, which surpassed that from hyoscyamine by 1 mm., was already attained in 35 minutes. The pupil remained of this size nearly five hours, when contraction began, which was still incomplete on the third day, at which time the pupil possessed a diameter of 4 mm.

If one compares this descending atropine curve with the atropine curve from the same concentration in a normal eye, it is evident that in the latter a pupil of 4 mm. width is obtained only on the fourth or fifth day.

Case XIX.—In an experiment (Fig. 19) upon a boy of 10 years the dilatation began in 15 minutes, and reached its maximum (8 mm.) in 30 minutes. Original diameter, 3 mm.; absolute enlargement, therefore, 5 mm.

Case XX.—In the third trial upon a young man of 19 years the mydriasis took place 15 minutes after the instillation, the maximum (7 mm.) being attained in 30 minutes; width of normal pupil 3 mm.; hence dilatation amounted to 4 mm. On the following day, in this as well as in the preceding case, the effects were no longer manifest.

Case XXI.—In the fourth experiment (Fig. 21), made upon a man 75 years old, dilatation commenced 20 minutes after the dropping in of the solution, but reached its maximum, which was only 6 mm., after 50 minutes had passed. The original diameter of the pupil being 3 mm., the enlargement was of the same amount. The subsequent day the pupil was of normal size.

The three following experiments were made with pure hyoscyamine, without acetic acid:—

Case XXII.—In the first trial (Fig. 22), upon a girl 27 years of age, the pupil began to enlarge 15 minutes after the instillation, and in 40 minutes was 7½ mm. wide. It remained at this height three hours, when contraction began, and on the next day her pupil was of normal diameter.

Case XXIII.—Dilatation began (Fig. 23) after 15 minutes, and reached its maximum (8 mm.) in 45 minutes, where it continued nearly three hours; then narrowing began, and on the following day the natural size was restored.

Case XXIV.—The third test, upon a girl aged 23 years, obtained very similar results, dilatation beginning in 15 minutes, and being at its height (8 mm.) in 40 minutes, which was maintained nearly three hours, and the next day all action had ceased.

After having employed this hyoscyamine in a strength of 1 : 200, we desired to know if a still weaker solution would dilate the pupil, and, with this object in view, one of the same preparation

was prepared in the proportion of 1 : 500 aqua, and I made seven experiments with it.

CASE XXV.—In the first trial, upon a girl 14 yrs., whose pupil, previous to instillation, was 2.5 mm. wide, there was in 25 minutes a diameter of 3.5 mm., and after 40 minutes of 4 mm. ; it continued of this degree almost 2 hours ; and in 4 hours the pupil was nearly like its fellow.

CASE XXVI.—In the second case, in which the original diameter of the pupil was 3 mm., it was enlarged after 40 minutes to 4 mm., and remained so about 2 hours.

CASE XXVII.—In the third case, where the normal size of the pupil was 2 mm., it attained after 40 minutes a diameter of 2.5 mm., and after 45 minutes of 3 mm. In one hour and five minutes the maximum was reached of 3½ mm., which lasted nearly 3 hours, and at the end of 4½ hours the effects had completely passed off. In the last three cases the pupils reacted the entire time upon the influence of light and accommodative movements.

CASE XXVIII.—The fourth case exhibited a scarcely perceptible dilatation, which in 4 hours was completely nil. The three other cases (29 to 31) manifested no reaction whatever.

It still remained for us to test the action of the crystallized hyoscyamine. Through the kindness of Prof. Valentin, who possessed, among others, the crystallized form in the collection of organic alkaloids from Heidelberg, we were enabled to make the necessary experiments. It appeared, when seen by the naked eye, as a white, shining mass, composed of crystals, which, under a microscope of a low power, were needle-shaped. It dissolved in water with difficulty, and in a very minute quantity, while the undissolved part fell to the bottom of the glass as a light flocculent precipitate, which did not dissolve upon the addition of acetic acid.

We tried first the cloudy solution of 1 : 500.

CASE XXXII. to CASE XXXVI.—Only twice out of five cases a minimum dilatation was obtained, and then not until after one hour and 45 minutes, and continuing but about 3 hours—once upon a girl of 27 yrs., and again upon one of 23 yrs. In the other three instances there was no reaction.

Afterwards we employed a solution of 1 : 200. To a part of this a few

drops of alcohol were added, and to the remainder a few of acetic acid. With both of these solutions six cases were tested.

CASE XXXVII. to CASE XLII.—Two cases exhibited after an hour and 10 minutes a small amount of dilatation, which lasted about 2 hours. Four cases showed no change. In consequence of the addition of alcohol or acid the instillation was accompanied by a very severe pain of brief duration, which was greatest from the acidified solution. The pure hyoscyamine caused no pain.

Reviewing the results of our experiments we arrive at the following conclusions:

The dark amorphous hyoscyamine, of the consistency of an extract, wherever it comes from, always acts rather energetically, although not as intensely as atropine. But it appears to lose its activity by becoming old, as is shown by comparing the results of our experiments with the amorphous preparation of Merk, with the earlier ones of Dr. Chopart. Perhaps the fault is in its preservation, as the London hyoscyamine which Prof. Dor possessed since 1870 manifested in all experiments a very good activity. The watery amorphous form from Darmstadt, made after Merk's method, is completely useless. This we could not assert with equal certainty of the crystals, although they exhibited in all the trials either no effect, or only a very weak one. This result may, however, be ascribed to the complete insolubility of the preparation employed, and hence one is hardly justified in deciding upon its activity without further tests.

Besides the determination of the quantitative action of hyoscyamine with the object of ascertaining its therapeutical value, it was interesting in the highest degree to solve the theoretical question of its physiological action. Inasmuch as qualitatively considered, its physiological action accords entirely with atropine; the explanation of the one must be influenced by that of the other; but as regards the modus operandi of atropine there has hitherto been no positive theory reached, a fact fully attested by the multitude of diverse theories which are held. One fact, however, remains tenable, and is generally accepted at present, which is, that its mydriatic action is a purely local phenomenon, to explain which two opposite theories are given. First, that it acts upon the *nerves* of the iris, and secondly, that it affects directly the *muscles* of the iris.

Upon the acceptance of the first supposition three conditions may be possible.

1st. A paresis of the oculomotor nerve.

2d. An irritation of the sympathetic.

3d. Both of these conditions.

In support of the second theory it is possible that there may be :

1st. A paresis of the fibres of the circular muscle, or

2d. An irritation of the radiating fibres.

Most authorities consider that there is a paresis of the N. oculomotorius associated with moderate irritation of the sympathetic. The defenders of this theory, to which Donders*, his pupils, Drs. de Ruiter, † Kuyper, ‡ Cramer, § Hoppe, ‖ and Biffo,¶ are adherents, have arrived at this opinion through the results of their own experiments, in which, after division of the sympathetic and the instillation of atropine, the pupil still dilated, but not so widely as that of the other eye. After section of the oc.-motor, or in a pathological paresis, it was still possible by the application of atropine to produce greater dilatation. The mydriasis from atropine, after cutting of the sympathetic, is explained by the paresis of the oc.-motor., and on the other hand, the farther enlargement from its instillation after division of the oc.-motor. is attributed to irritation of the sympathetic.

Braun ** asserts, in his dissertation as deduced from the results of his experiments in favor of a pure paresis of oc. motor. that after division of the sympathetic there was a constant dilatation of the pupil. He believes that it is possible in the beginning of the mydriasis to exclude irritation of the sympathetic and assume a paresis of the oculomotorius. Among the supporters of the theory of irritation of the sympathetic appears Laurent ††, who in-

* De Werking der Mydriatica en der Myotica, door F. C. Donders, pp. 21–27.

† De Actione Atropæ Belladonnæ in Iridem.

‡ Onderzoekinger betrekkelijk de Kunstmatige Verwijding van den Oogappel.

§ Physiologische Abhandlung über das Accommodationsvermögen des Auges, übersetzt von Dr. Doden. Leer, 1855, S. 162.

‖ Die Nervenwirkung als Heilmittel, Heft 1, Leipzig, 1855.

¶ In Omodei Annal., 1846, T. 118, p. 635.

** Diss. inaug. Experimenta nonnula ad illustrandum affectum atropini aliorumque quorundam mydriaticorum. Henricus Braun, p. 29.

†† De l'Hyoscyamine et de la Daturine, étude physiologique, par le Dr. Ch. Laurent.

dependently obtained corroborating results from his experiments. He found, after exsection of an upper cervical ganglion and the subcutaneous injection of hyoscyamine, a very small dilatation of the pupil upon the same side, which began much later than it did in the other eye. He believes from this that the theory explaining sympathetic irritation is substantiated. Richter * also in his dissertation announces the same belief.

The supposition that the poison acts upon the *muscles* of the iris has not so many adherents as the former, and the few who uphold it are not agreed with one another. According to some there is an irritation of the dilatator, and according to others a paralysis of both muscles in which a weakness of the sphincter preponderates. LEMATRE † is a supporter of the first view, because he obtained no dilatation from atropine upon birds, and it is the opinion of Wharton Jones ‡ that the dilatator pupillæ of the iris of birds is wanting. The defenders of the second supposition are BUDGE § and JOHNES ; ‖ they concluded that muscular action exists partially from the absence of mydriasis in birds whose iris consists of smooth muscular fibres, and partially from experiments where dilatation was induced even 15 months after division of the sympathetic, as well as after section of all the nerves.

In order to be able to pronounce upon the one or the other of these theories we made a series of experiments, the results of which we will here communicate.

The experiments were as follows:

After having convinced myself by dropping atropine into the conjunctival sac of a rabbit, and at the same time into the eye of a man, that the dilatation was the same in each case, except that upon the animal its action was neither so intense nor so continuous, it was possible to test its effects after section of the sympathetic. With this object in view division of this nerve in the neck was made by Prof. Valentin upon four rabbits.

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* Diss. inaug. De atropini in oculum efficacitate.

† Archives de Médecine. Recherches expérimentales et cliniques sur les Alcooïdes de la famille des Solanées, par Gustave Lematre, p. 62, Juillet, 1865.

‡ Medical Times, 1857. Clinical Lectures on the action of belladonna on the pupil, by Wharton Jones.

§ Ueber die Bewegung der Iris; für Physiologen und Aerzte, p. 180.

‖ Diss. inaug. Analecta et experimenta de effectu atropæ Belladonnæ in iridem.

The effects after the operation were as usual—a contraction of the pupil, enlargement and injection of the vessels of the ears with an increase in temperature. Prof. Valentin requested me not to try the hyoscyamine immediately after the operation, but to wait a few days. Unfortunately these experiments were not carried out, for the rabbits all died. For this accident the operation cannot be directly blamed, as the other rabbits, upon which only the instillation of hyoscyamine had been made, likewise died because of the winter cold. I procured, therefore, for further experiments, a dog, which could stand both the winter cold and the operation much better.

The dog was a black, middle-sized animal, upon which the division of the vago-sympathicus in the neck was made by Prof. Valentin, and a piece exsected. The effect was successful, as immediately contraction of the pupil with elevation of the temperature of the ear upon the operated side took place. The diameter of the pupil of the eye upon the same side fluctuated with changes of light between 1½ mm. and 2 mm., and that of the other eye, under similar conditions, between 4 mm. and 5 mm.

The experiments with the hyoscyamine were not made immediately after the operation, but a week and a half later when all reaction and suppuration from the wound had ceased.

I employed the hyoscyamine disks, because this was the surest preparation, and it was our object to learn whether hyoscyamine would act at all after division of the sympathetic.

Before introducing the disk, the pupil of the left eye (the side of the operation) possessed a width of 2 mm. and that of the right eye of 4 mm.

(Fig. 24.) The dilatation began in both eyes 15 minutes after the application, and exhibited upon the right eye a diameter of 5 mm., and upon the left of 3 mm. The maximum reached after 1 hour, was in the right eye 11 mm., in the left 8 mm., and on the following morning it was in the right 7 mm., in the left 5 mm. In the afternoon of this day the diameter of the right pupil was 6 mm., of the left 3½ mm., and on the third day both pupils were of their original size.

This test establishes a fact already observed in various experiments, viz.: that atropine, resp. hyoscyamine, can produce a dilatation even if the innervation of the sympathetic is suspended. Hence it follows from these results that the mydriasis originates not through an irritation of the trunk of the sympathetic, but by an irritation of its terminal fibres which remain intact in the iris.

The action of the sympathetic can only be entirely excluded when it is possible completely to destroy its termination in the iris. Directly, of course, this is impossible; but indirectly we may attain the same result, for destruction of the nerve ends may be brought about by nature's action. If we divide the trunk of the nerve its central as well as the peripherical portions are destroyed by fatty degeneration, and lose their excitability. In case that under these conditions dilatation takes place, irritation of the sympathetic ends must be excluded, but on the other hand the absence (or delay) of mydriasis would be a positive proof that the dilatation of the pupil depends on an irritation of the terminal fibres of the sympathetic. To test this I intended to make appropriate experiments after the expiration of a few months.

In the meantime I repeated, after 14 days, the former tests in which I again used the hyoscyamine disks, and obtained the same results as before.

(Fig. 25.) The left pupil had a width of 1½ mm., the right of 4 mm. After 15 minutes, dilatation commenced, and the pupil showed in the left eye a diameter of 3 mm., in the right of 5 mm. The maximum was attained in one hour, and was in the right eye 11 mm., in the left 8 mm. The subsequent day the right pupil was 7½ mm., the left 5 mm. On the third day all action had ceased.

The results of experiments made after 2 months were similar to the former, but not in every respect, as the dilatation in the left eye was slower than the first time.

(Fig. 26.) Before introducing the disks the right pupil had a diameter of 4 mm., the left of 2 mm., 15 minutes afterwards the right pupil was 5½ mm., the left 2½ mm. The maximum was attained in both eyes in an hour, being in the right eye 11 mm., in the left 7 mm. BUDGE* obtained dilatation from atropine upon the rabbit 13 months after division of the sympathetic.

Considering the fact that already 6 weeks after the division† of nerves, their final degeneration is established, the action which is said to follow the irritation of the nerve ends cannot

* Ueber die Bewegung der Iris. Für Physiologen und Aerzte, p. 180. Julius Budge.
† Lehrbuch der pathologischen Gewebelehre, von Dr. Ed. Rindfleisch, p. 20, § 32.

take place after 2 months—much less after 13 months. Hence one can infer with tolerable safety that irritation of the sympathetic is not the cause of the mydriasis. The slower dilatation upon the side of the divided sympathetic is easily explained when one assumes a paresis of the oc.-motor. or of the smooth muscles of the iris as the cause of the dilatation. Upon the application of atropine to the normal eye, we have a paresis of the oc.-motor. and a natural tone of the sympathetic, consequently two conditions which assist the enlargement of the pupil. But in the eye upon the side of the cut nerve we have only paresis of the oc.-motor. without the natural tone of the sympathetic; hence the dilatation must be slower and depend alone on the elasticity of the muscles, as both antagonists are now paretic. By accepting this view it is explained why we obtained in the last experiment only 7 mm. dilatation in the left eye, while in the former 8 mm. preponderated. The continued tension during 2 months may have caused a certain degree of habitual contraction of the sphincter in consequence of which the dilatation of the pupil was slower and less complete. These facts, I think, demonstrate that the dilatation of the pupil does not result from an irritation of the sympathetic nerve.

Two questions now remain to be answered, namely: whether there is a paresis of the oc.-motor. nerve or a paresis or irritation of the smooth muscles of the iris. Prof. Valentin was of the opinion that the mydriatic acted upon the smooth muscles of the iris without the direct mediation of the terminal nerves. In order to establish this view he advised me to test the action of hyoscyamine upon birds, whose irides consist of the same parts as those of the mammalia, and are distinguished from the latter only by the striated structure of their muscular fibres. The assertion by a few authors, as Wharton Jones, Maunoir, and Budge, that the iris of the bird possesses no dilator is now no longer tenable, but the opposite view, founded upon positive facts by Kölliker and Heinrich Müller, assert that there exists both a dilator and sphincter in the iris of birds; and as positive facts are always of more value than negative ones, in the present instance the last view appears the more correct. By a few the dilator was assumed to consist of smooth muscular fibres (Cramer), but by others (Kölliker, Heinrich Müller) of striated

fibres. If the first question were settled we might form a conclusion of the manner of the action of atropine from its behavior upon the iris of birds. For, were the theory of muscular paresis correct, then atropine must produce a contraction of the pupil upon birds instead of a dilatation, but should this not be the case, which is really the fact, it would oppose the belief in a paresis of the smooth muscular fibres. But as the nature of the muscular fibres of the dilator remains at present unsettled, the behavior of the birds' iris towards atropine in this sense does not explain the phenomena. After these preliminary remarks, I will now communicate the results of experiments upon a pigeon.

I instilled into the eye of a young pigeon a solution of hyoscyamine of 1 : 200, which was repeated in 30 minutes. There was no alteration of the pupil perceptible. A few days later, I introduced into the eye a hyoscyamine disk, which was also completely without effect. After a short time I repeated the experiment, first putting one disk in place followed in the course of half an hour by two more disks. The results, however, were the same as before. In all these cases I observed the pigeons during 5 hours without noticing any change in the diameters of their pupils. Hence I wished to ascertain whether hyoscyamine produced a general action in birds as in man and mammal, and whether it acted as a poison upon birds at all. If this should not be the case, then the experiments upon the eyes which gave no negative results would not warrant us to make the conclusions which we otherwise would form. If it does not affect birds at all, then it must depend upon their peculiar organization, which we at present cannot explain, and its inefficiency upon the iris must be ascribed to its general inefficiency. In order to solve this question, I injected 0.01 gr. of hyoscyaminum purum from London. There was some acceleration of the respiration, but I could not attribute it positively to the effect of the poison, because the animal made attempts to fly, after which there is always an increase of respiration. Other phenomena were not perceived. The pupils retained their natural diameters. The second time I injected a larger dose, 0.0 25 gr., which likewise produced no distinct results. Hence I injected a still stronger dose—nearly 0.1 gr. In five minutes there was commencing relaxation, then paresis of the muscles followed, so that the animal could no longer stand, the neck and head were thrown back, respiration became gradually slower, with repeated spasms of the muscles of respiration, and after 9 minutes the bird was dead. The pupils were dilated,

but this could not be ascribed directly to the hyoscyamine, because in death by asphyxia the pupils are always dilated, and in this instance death probably occurred through a paresis of respiration. hence there was asphyxia, so that the enlargement of the pupils cannot be attributed to the specific action of the hyoscyamine. To ascertain if the hyoscyamine was really inefficient I injected into the orbital cellular tissue 0.02 gr. purum of Sittel. But it was likewise without effect.

After obtaining these results I believe myself justified in the conclusion, that hyoscyamine is wholly without action upon the irides of birds. Other conclusions we have already communicated above, but shall return to these results farther on, together with other facts.

From these experiments it appeared to me necessary to make a division of the oculomotorius, after which should dilatation take place, which has indeed been observed, it would directly prove that there is no paresis of this nerve in mydriasis. While after division of the sympathetic, dilatation is still possible by irritation of the nerve ends, the same reasoning cannot be employed in the case of the oc.-motor. as the experiment must have a paralyzing effect on this nerve. But if the tonus, which emanates from the centre to the muscles, is abolished by section of the nerves, the poison, which is said to have the same effect as the section, cannot show its influence. Prof. Valentin advised me not to make this experiment, as its execution is attended with considerable difficulty, and the animals perish during its performance. He, therefore, advised me to pursue another course, which would lead to the same results, namely : to remove rabbit's eyes, put them in a warm place, and then to inject hyoscyamine into the anterior chamber. If dilatation should then occur, it would prove that the mydriasis did not depend upon paralysis of the oculomotorius.

For this purpose the eyes of a white rabbit were extirpated immediately after it was killed, they were put in a warm room of 40° C., and hyoscyamine at once injected into the anterior chamber of one eye, while, for the sake of comparison, nothing was done to the other eye. Before the injection of the hyoscyamine both pupils were equal to 4 mm.

Experiment I.

Hyoscyamine injected.							Nothing done.	
3	hours,	25	min.,	pupil	3	mm.	4	mm.
3	"	30	"	"	$3\frac{1}{2}$	"	4	"
3	"	35	"	"	4	"	4	"
3	"	45	"	"	5	"	$4\frac{1}{2}$	"
4	"	—	"	"	$5\frac{1}{2}$	"	5	"
4	"	15	"	"	$5\frac{1}{2}$	"	$5\frac{1}{2}$	"
4	"	30	"	"	$5\frac{1}{2}$	"	$5\frac{1}{2}$	"
5	"			"	$5\frac{1}{2}$	"	$5\frac{1}{2}$	"

The maximum dilatation in the injected eye was reached at four o'clock ; in the one not injected, at 4:15. Therefore, the hyoscyamine only slightly accelerated the process of dilatation, this may have been due to accidental causes.

The dilatation in the injected eye amounted to $2\frac{1}{2}$ mm. (from 3 to $5\frac{1}{2}$ mm.) ; in the other only to $1\frac{1}{2}$ (from 4 to $5\frac{1}{2}$ mm.). On the following day, therefore, I repeated the experiment on another rabbit. I made the measurement every five minutes, but I only mention those in which alterations were noticed in one or the other eye.

Experiment II.

							Nothing done.	
3	hours	—	min.	Pupil	4	mm.	3, 5	mm.
Immediate after injection of hyoscyamine.								
3	hours	5	min.	Pupil	5	mm.	3, 5	mm.
3	"	10	"	"	6	"	4	"
3	"	15	"	"	6, 5	"	5	"
3	"	35	"	"	6, 5	"	5, 5	"
4	"	—	"	"	6, 5	"	6	"
4	"	15	"	"	7	"	6, 5	"
4	"	45	"	"	7	"	6, 5	"
5	"	—	"	"	7	"	6, 5	"
5	"	30	"	"	7	"	6, 5	"

In the execution of both of these experiments a source of error existed. The first time, the warm place was too dry ; the other time, there was too much fluid in the bottom of the vessel, and as both eyes were in one vessel, hyoscyamine could enter the other by diffusion of water into the bulbi,

and the marked dilatation of the eye not injected with hyoscyamine, was perhaps, caused in this way. I, therefore, made two other experiments, endeavoring to avoid the former sources of error.

The eyes were isolated, the vessels containing them well closed and lined with moist paper, by means of which the measurements became more difficult, on account of the condensation of vapors upon the glass. Both pupils were of equal width, 3 mm.

Experiment III.

	Hyoscyamine injected.	Nothing done.
3 hours, 20 min.	Pupils 3 mm.	Pupil 3 min.
3 " 25 "	" 4 "	" 3 "
3 " 30 "	" $4\frac{3}{4}$ "	" $3\frac{1}{2}$ "
3 " 35 "	" $5\frac{1}{4}$ "	" 4 "
3 " 40 "	" $5\frac{1}{2}$ "	" $4\frac{1}{4}$ "
3 " 45 "	" $5\frac{1}{2}$ "	" $4\frac{1}{2}$ "
3 " 50 "	" $5\frac{1}{2}$ "	" $4\frac{3}{4}$ "
3 " 55 "	" 6 "	" 5 "
4 " — "	" $6\frac{1}{2}$ "	" 5 "
4 " 05 "	" 7 "	" 5 "
4 " 10 "	" $7\frac{1}{2}$ "	" 5 "
4 " 25 "	" 8 "	" 6 "
4 " 50 "	" $8\frac{1}{2}$ "	" $6\frac{1}{4}$ "
5 " — "	" $8\frac{1}{2}$ "	" $6\frac{1}{4}$ "
5 " 30 "	" $8\frac{1}{2}$ "	" $6\frac{1}{4}$ "
6 " 30 "	" $8\frac{1}{2}$ "	" $6\frac{1}{4}$ "

I let the bulbi lie in a closed room until the following day. The next morning the pupil of the injected eye had a diameter of $7\frac{1}{2}$ mm., that of the other $6\frac{1}{4}$ mm.

It follows then from this experiment that the pupil dilates after death, but that the dilatation is much greater in the eye in which hyoscyamine was injected. We can also draw the conclusion therefrom that hyoscyamine acts as a mydriatic on eyes which have been enucleated, and we may also regard this as a confirmation of the above-mentioned theories, only bearing in mind the caution that other circumstances may produce this dilatation. At first I thought that perhaps the increase in the intra-ocular pressure, produced by the injection, was the cause of the dilatation.

I therefore repeated the experiment once more, but in the same way injected water instead of hyoscyamine, and attained nearly the same results.

Experiment IV.

9	hours	15	min.	Pupil	4	mm.	Pupil 4	mm.
				Water injected.			Nothing done.	
9	hours	20	min.	Pupil	4½	mm.	Pupil 4	mm.
9	"	30	"	"	4½	"	" 4	"
9	"	40	"	"	4½	"	" 4	"
10	"	—	"	"	5	"	" 4½	"
10	"	10	"	"	6	"	" 4½	"
10	"	15	"	"	7	"	" 4½	"
10	"	20	"	"	8	"	" 4½	"
10	"	25	"	"	8½	"	" 4½	"
10	"	45	"	"	8½	"	" 5	"
10	"	50	"	"	8½	"	" 6	"
11	"	—	"	"	8½	"	" 6	"
11	"	30	"	"	8½	"	" 6	"
11	"	45	"	"	8½	"	" 6	"

It follows therefore that water, as well as hyoscyamine, produces dilatation of the pupil; but this may depend either upon increase in intra-ocular pressure, or the more rapid loss of vitality caused by a foreign fluid. To exclude the increase of intra-ocular pressure as a cause of dilatation, I made incisions into the posterior wall of the globe, and repeated the same experiment, first with water, and then with hyoscyamine.

Experiment V.

10	hours	35	min.	Pupil	4	mm.	Pupil 4	mm.
10	"	40	"	Hyoscyamine injected.			Nothing done.	
10	"	45	"	Pupil	4	mm.	Pupil 5	mm.
10	"	55	"	"	4¾	"	" 5	"
10	"	10	"	"	6	"	" 5	"
11	"	40	"	"	7	"	" 5½	"
12	"	20	"	"	7	"	" 6	"
12	"	30	"	"	7	"	" 6	"
12	"	45	"	"	7	"	" 6	"
1	"	—	"	"	7	"	" 6	"

Experiment VI.

3 hours 25 min.	Pupil 4 mm.		Pupil 4 mm.
3 " 30 "	Water injected.		
3 " 40 "	Pupil 5 mm.		" 6 "
3 " 50 "	" 5 "		" $6\frac{3}{4}$ "
4 " 20 "	" 6 "		" $6\frac{1}{2}$ "
4 " 35 "	" 7 "		" 7 "
4 " 40 "	" $7\frac{1}{2}$ "		" 7 "
4 " 50 "	" $7\frac{1}{2}$ "		" 7 "
5 " — "	" 8 "		" 7 "
5 " 30 "	" 8 "		" 7 "
6 " — "	" 8 "		" 7 "

As the water in this case may act as a mydriatic, Prof. Valentin advised me to omit it entirely, and to apply the hyoscyamine, in powder, directly to the iris.

I performed this experiment in the following way:—After extirpating the eyes, as in the former case, I removed the cornea by a circular incision, and applied to the now exposed iris 0.001 of hyoscyaminum purum from London, of the activity of which I had convinced myself. In the other eye I removed the aqueous humor by tapping, and injected pure water into the anterior chamber.

	Experiment VII.	Experiment VIII.
4 hours — min.	Cornea removed.	Water injected.
	Pupil 5 mm.	Pupil 3 mm.
4 " 5 "	" $5\frac{1}{2}$ "	" 3 "
4 " 15 "	" $5\frac{1}{2}$ "	" 3 "
4 " 25 "	" $5\frac{1}{2}$ "	" 4 "
4 " 45 "	" $5\frac{1}{2}$ "	" 6 "
5 " — "	" $5\frac{1}{2}$ "	" $6\frac{1}{2}$ "
5 " 30 "	" $5\frac{1}{2}$ "	" $6\frac{1}{2}$ "
6 " — "	" $5\frac{1}{2}$ "	" $6\frac{1}{2}$ "
6 " 30 "	" $5\frac{1}{2}$ "	" $6\frac{1}{2}$ "

After more than an hour had elapsed, and no further dilatation was apparent, I discontinued measurements, but left the eye in the closed room. On the following day the pupil of the eye of which the cornea had been removed exhibited a greater dilata-

tion than on the previous day, namely, 7 mm., while in the other eye it was only 4 mm. The subsequent dilatation may be explained in two ways: either the hyoscyamine acts slower in the form of a powder, when it is first dissolved in the fluid of the eye; or, if the dilatation of the enucleated eye was only a phenomenon of death, the dilatation may have been retarded by the contact or adhesion of the iris and lens, in consequence of the loss of the aqueous humor; and this, therefore, would explain the subsequent dilatation, as another resistance must be overcome. This circumstance induced me to make another experiment.

To decide the question, whether the powder acts slower than the solution, I introduced 0.002 gram. of powdered hyoscyamine into the conjunctival cul-de-sac of a living rabbit, into the other one the same quantity in solution. Before the experiment both pupils were equal.

Experiment IX.

2	hours	45	min.	4–5	mm.
	Powdered hyoscyamine.				
3	hours	—	min.	6	mm.
3	"	5	"	7	"
3	"	10	"	7½	"
3	"	15	"	8	"
3	"	20	"	8	"
3	"	40	"	8	"
4	"	—	"	8	"
4	"	30	"	8	"

Experiment X.

Pupil	4–5	mm.
Solution of hyoscyamine.		
Pupil	6	mm.
"	6½	"
"	7	"
"	7½	"
"	8	"
"	8	"
"	8	"
"	8	"

It follows, therefore, that powdered hyoscyamine acts with the same intensity as that in solution; and if the greater dilatation at first was not caused by accidental circumstances, it acted with even greater intensity.

I therefore made another experiment, again applying the hyoscyamine to the iris. This experiment differed from the preceding only in that I removed the cornea of both eyes, and to the iris of one eye I applied between 0.0023 and 0.0025 of a gr. of pulverized hyoscyamine; while, for the sake of comparison, nothing was done to the other eye after the removal of the cornea.

	Experiment XI.	Experiment XII.
4 hours — min.	Pupil 4 mm.	Pupil 4 mm.
	Powdered hyoscyamine.	Nothing done.
4 hours 5 min.	Pupil 4 mm.	Pupil 4 mm.
4 " 15 "	$4\frac{1}{2}$ "	" $4\frac{1}{2}$ "
4 " 30 "	5 "	" 5 "
4 " 35 "	$5\frac{1}{2}$ "	" $5\frac{1}{2}$ "
4 " 45 "	$5\frac{1}{2}$ "	" $5\frac{1}{2}$ "
5 " — "	$5\frac{1}{2}$ "	" $5\frac{1}{2}$ "
5 " 30 "	$5\frac{1}{2}$ "	" $5\frac{1}{2}$ "
6 " — "	$5\frac{1}{2}$ "	" $5\frac{1}{2}$ "
6 " 30 "	$5\frac{1}{2}$ "	" $5\frac{1}{2}$ "
7 " 30 "	$5\frac{1}{2}$ "	" $5\frac{1}{2}$ "

On the following days, both pupils $5\frac{1}{2}$ mm. wide.

If we now put the results of all the experiments together, they are as follows :—

1. Hyoscyamine acts as a mydriatic when the sympathetic is divided, even two months after the section.

2. Hyoscyamine in strong concentration produces no mydriasis when introduced into the eyes of birds, though it produces a general effect when injected subcutaneously.

3. Hyoscyamine does not produce any dilatation of the pupil in enucleated eyes. We were brought to this conclusion by the following facts:

a. Injection of a solution of hyoscyamine into the anterior chamber causes dilatation. But a similar dilatation is caused by the mere injection of water.

b. Dilatation caused by the injection of either water or hyoscyamine is not the result of increase of intra-ocular pressure.

c. The immediate application of pulverized hyoscyamine to the iris does not produce dilatation of the pupil.

CONCLUSION.

If we now ask ourselves whether we have arrived at any ultimate conclusion as to the physiological action of hyoscyamine, we must confess that we have not made great progress. From a

severe criticism of all the theories advanced, to explain the results obtained, it follows that not a single one accounts for them sufficiently well. If we cannot come to any incontestible conclusion by the best way—that of experiment—it may be possible to approach the truth by theoretical reasoning, viz., by exclusion of some of the advanced theories. First of all we have to set aside the theory of simple irritation of the sympathetic, as it does not satisfactorily explain either the results of the experiments nor the entire complex of symptoms which are caused by mydriatics. For, if we had to deal only with irritation of the sympathetic, how could we explain the paralysis of accommodation? And there is no doubt but that this exists.

Certainly the accommodation for near objects would suffer in consequence of the decrease of refraction, and the spherical aberration resulting from the dilatation of the pupil, because the interruption of the peripheral rays is not possible during mydriasis.

This disturbance would manifest itself only by indistinctness of the image, whereas the application of atropine makes the near point recede from the eye by paralyzing the muscle of accommodation. This muscle, the so-called Brücke's muscle, is innervated by the oculomotorius, and is in no connection with the sympathetic. The theory of an irritation of the sympathetic is in discord with the results of a division of the sympathetic, after which mydriatics still produce a dilatation of the pupils. In consideration of this fact the theory has been so modified that an irritation of the periphery of the nerve, instead of its trunk has been assumed. But even this theory is contradicted by our experiments on dogs, as well as by Budge's experiments on rabbits, thirteen months after section of the sympathetic. We have already, above, sought to explain the fact why the dilatation of the pupil is less after division of the sympathetic.

The theory of paralysis of the oculomotorius seems to us to be more plausible, as it explains the whole complex of symptoms produced by the action of atropine. Brücke's muscle, as well as the sphincter iridis, being innervated by the oculomotorius, there must be mydriasis and paralysis of accommodation when this nerve is paralyzed. Furthermore, the results of many experiments support this theory.

First, the occurrence of dilatation when, after section of the sympathetic, atropine is applied. Secondly, our and Laurent's experiments, made on the enucleated eyes of rabbits, in which no dilatation took place after the use of hyoscyamine. For, if the tonic innervation of the muscle be suspended by section of the nerve, a poison, which is supposed to have a similar action (paralyzing), can no longer exert its influence.

Against this theory, too, is the increase of an already existing atropine mydriasis by section of the oculomotorius, which can be readily explained by the paralysis becoming complete. But the fact is not explained that, after section of the oculomotorius, instillations of atropine cause a still further increase of dilatation. Moreover, it remains unexplained why the paralysis should be confined to the terminations of the oculomotorius in the iris and Brücke's muscle, and not extend to the remaining parts supplied by this nerve, so as to cause ptosis, divergent strabismus, etc. Such a series of phenomena are never produced by the poison, even in the largest doses, or by the strongest local applications. The diplopia which ordinarily ensues is monocular, and therefore depends upon mydriasis and paralysis of accommodation, and not upon divergence. It also remains unexplained why the substance does not cause any mydriasis when applied to the bird's iris, as the sphincter iridis of birds is also supplied by the oculomotorius, although it differs from those of the mammalia and amphibia by transverse striation of the muscular fibres.

If these last two objections only existed, we should reply that the existence of smooth muscular fibres are necessary to the occurrence of paralysis of the terminations of the oculomotorius, therefore the inactivity of the substance on the bird's iris and the muscles of the eye.

This theory, together with the facts above mentioned, does not suffice to explain all the phenomena. The last mentioned objection brought us to the third theory, that of paralysis of the smooth muscular fibres of the iris and of the ciliary muscle. It explains the inactivity of the drug on the bird's iris, and the non-occurrence of paralysis of the muscles of the eye, which is not readily explained by the last theory. But, as the action must be a paralyzing of the muscle, it is not easy to understand why mydriasis should occur, as the paralysis must extend to both the

sphincter and dilator pupillæ. Budge, who defends the theory of paralysis of the muscle, offers the following explanation. He says: * "If we consider the fact that the sphincter is more readily excited, but also loses its activity sooner than the dilator muscle, which can be excited much longer, and if we further consider that the former muscle contracts the pupil more than the latter dilates it, we must conclude that belladonna, which robs both cylindrical muscles of their contractility and tonus, paralyzes the sphincter more than the dilator, that is to say, it dilates.

"The sympathetic nerve, which in its normal condition is endowed with more power of resistance than the oculomotor nerve, will protect the muscle to which it is distributed against the paralyzing action of atropine longer than the oculomotor will protect the sphincter muscle. But if one of the muscles is still active, while the other is temporarily paralyzed, the still existing nerve force of both motor nerves of the iris can manifest itself only in those muscular fibres which are still able to offer resistance. The dilator muscle, therefore, will, by this antagonistic relation, obtain the advantage. It is very possible, therefore, that by the action of the mydriatic the pupil becomes wider than after death."

By accepting this theory, it is easy to explain why mydriatics cause a paralysis of accommodation; for the ciliary muscle also consists of smooth muscular fibres, and it follows that a poison, which produces paralysis of the latter, must also paralyze this muscle. Moreover, there are two other arguments in favor of the occurrence of paralysis of the smooth muscular fibres of the body, namely: first, the inactivity of atropine and hyoscyamine on the bird's iris, and second, its paralyzing effect on all the other smooth muscular fibres of the body. It is proven by the experiment of Bezold and Laurent that atropine paralyzes the smooth muscular fibres of the intestine. Bezold found, on opening the abdominal cavity of animals which had been poisoned by atropine, that the intestines and ureters were immovable, and that strong mechanical and electrical irritation were required to produce contractions of the small intestine and colon.

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* On the Movements of the Iris. For Physiologists and Physicians, by Julius Budge, p. 184.

But if the poison was applied directly to the smooth muscular fibres, then even the strongest irritation did not produce any contraction. Laurent, in his experiments, observed a similar behavior of the smooth muscular fibres, namely, a loss of excitability when irritations were applied, while the striped muscular fibres retained their irritability completely. Paralysis of the rectum and bladder with involuntary evacuations was also often noticed. The smooth muscular fibres of the iris could not, therefore, be expected to make an exception to the general rule of the action of atropine upon these muscles. This theory also harmonizes with the results of our experiments on the enucleated eyes of rabbits in which no dilatation was caused by the use of hyoscyamine. The dilatation which did occur in our experiments, must be regarded as due to the presence of a foreign fluid, since it was caused even by pure water. But if this theory explains some phenomena very well, it still is not sufficient to account for some others. For instance, it is not very easy to comprehend why atropine continues to cause dilatation after section of the oculomotorius and, according to Budge, after the section of all the nerves which supply the iris and ciliary muscles. For, if the muscles are once paralyzed in consequence of division of the nerves which supply them, they can then only be influenced by their own elasticity.

An irritation, now exerted upon the muscles of the iris, may still cause a diminution in the size of the pupil, as the muscles have not yet lost their direct irritability, but a paralyzing effect upon them could not be proved, unless we could demonstrate it in some other way than by alteration in the width of the pupil. For, by paralysis of the muscles we understand their loss of ability to respond to irritations, no matter whether these are continuous or momentary. Such a paralysis must manifest itself by the suspension of its tonic conditions (which is proved for the muscles of the iris), and by the preponderance of the still unparalyzed antagonistic muscles. Therefore, if the action of atropine consisted in a paralysis of the muscular fibres, dilatation could not occur in an eye which had been severed from its connections. For, the two factors upon which we depend to demonstrate the action of the poison are now wanting, namely, the tonic contraction of the paralyzed muscle and the preponderance of its an

tagonist. But if dilatation of the pupil occurred even then, as was observed by Budge, it cannot, according to our opinion, support the theory of muscular paralysis, as accepted by him, for, if it does not absolutely refute this theory, it at least cannot be regarded as accounting for all the facts. The occurrence of dilatation under these circumstances can only be explained by an active contraction of the dilator. Let us now try to ascertain in which way this contraction may occur. A direct irritation of the smooth muscular fibres is not probable for the following reasons:

First, if the action of the substance consisted in an irritation of the smooth muscular fibres, the occurrence of mydriasis could not be easily explained, as the irritation must act on both muscles of the iris; the sphincter, which is the stronger of the two muscles, would then preponderate, and instead of mydriasis, we should have myosis. Secondly, this supposition does not explain the paralysis of accommodation, for, as the ciliary muscle also consists of smooth muscular fibres, it would be irritated, and spasm of accommodation would therefore result. For reasons above mentioned, contraction of the dilator through irritation of the terminal filaments of the sympathetic cannot be accepted.

The occurrence of dilatation under these circumstances can also be accounted for by the supposition that there are ganglia in the substance of the iris, the action of atropine and hyoscyamine would then be explained by paralysis of the smooth muscular fibres of the iris and ciliary muscle, and concomitant irritation of the ganglia, which would shorten the dilator pupillæ. This would also explain all the phenomena which were observed in the experiments, as well as mydriasis after section of the sympathetic, the further dilatation by atropine after section of the oculomotorius, the paralysis of accommodation and so forth.

This opinion can only be confirmed by careful microscopical examination.

Supplement to Rosa Simonowitsch's paper on Hyoscyamine, by Professor Dor, of Bern.

Rosa Simonowitsch's paper, which lies before us, was originally intended to comprise the influence of hyoscyamine on the

accommodation, and its action in pathological cases. As, on account of the departure of the authoress, these two chapters were not concluded. I have undertaken to elaborate them. I have also made measurements, and my present assistant, Dr. Sterki, has calculated and graphically illustrated the curves, but their publication would be premature, on account of the unequal effects of the individual preparations. The action of gelatinous atropine and hyoscyamine disks from Turin are most easily compared, and it is then seen that the action of hyoscyamine is always less than that of atropine, both as regards the degree of paralysis of accommodation and the duration of its action.

The *pathological cases* in which I have obtained the best results from the use of hyoscyamine are cases of interstitial keratitis, where, after a treatment lasting for weeks with atropine, pressure bandage, warmth, etc., no improvement took place; but where, after the use of hyoscyamine from one to two days, the pathological condition was altered, and the patient restored to health. There was no atropine conjunctivitis or idiosyncrasy against atropine in these cases. I have also found hyoscyamine valuable in some cases of chronic iritis, in which the use of atropine had to be discontinued.

I should have reported these cases more minutely if the observations of Simonowitsch had not plainly proven, in spite of the assertions of the pharmaceutists, that we have no pure hyoscyamine.

Of all the preparations in use, the only active ones are those in the form of extracts; the crystalline preparations from Prof. Valentin's collection (which was received from Sittel), as well as the last preparation made by Merk, by distillation in hydrogen gas, have no mydriatic action. Furthermore, the latter in all its reactions and external form is so similar to coniine that it is questionable whether it really is hyoscyamine. We may conclude, therefore, that there is a substance in the extract of hyoscyamine which has a strong mydriatic action, all the dark brown preparations (probably prepared by chloroform) have in some degree the properties characteristic of hyoscyamine, but the article commonly sold by chemists as pure hyoscyamine is without any mydriatic action. This fact may be explained in two ways, first, if these preparations really are hyoscyamine, then

hyoscyamine has no mydriatic action, and the mydriatic constituent must be sought for in the residue; or secondly, the real hyoscyamine is contained in the residue, and the alkaloids obtained must receive new names, as they are new chemical combinations. So long as this problem is unsolved by chemists it is useless to make any further experiments, and for therapeutic purposes we must employ only the extracts of hyoscyamine: those of Morton, that formerly made by Merk, the last preparation of Sittel, and that of Heberlein, of Milan, that is, the Turin gelatine disks.

OBSERVATIONS UPON THE PATHOLOGY AND THERAPEUTICS OF GLAUCOMA.

By Dr. J. HIRSCHBERG, Lecturer in Berlin.

(Translated by Dr. F. A. Munson, of Albany, New York.)

As chronic glaucoma and cataract are prevalent diseases of advanced years, no wonder that the former appears frequently complicated with the latter. But the diagnosis, although at times somewhat difficult, can be ascertained by a careful examination of the intra-ocular pressure and the visual field, together with a comparison of the two eyes.* It may, however, be hazardous to render the diagnosis easier by the use of atropine, as by it chronic glaucoma may be transformed into acute glaucoma. (See A. v. Graefe, Arch. f. Ophth. xiv., 2, 117; xv., 3, 123 and 197; also Hasket Derby, Transact. of the American Ophth. Society, 1869, p. 35; and Klinische Beob. ans der Augenheilanstalt von Dr. J. Hirschberg, 1874, p. 10.)

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* Mr. F., aged 72 years, consulted me for the first time on the 28th of March, 1870. He had beginning cataract in the right eye with $S = \frac{15}{200}$; Jäg. 5 with + 7. There was no contraction of the visual field and the left eye was normal in every respect. Upon the 20th of October, 1873, he returned on account of increasing dimness of sight in the right eye.

Examination.—L. Jäg. 1 at 5″ with + 6. Visual field entire. *Cataracta incipiens.* Nearly complete but shallow excavation of the papilla. Tension somewhat increased. Chromopsies. R. Fingers eccentrically and to the outer side at 2′. Cloudiness of the nucleus of the lens; papilla invisible. Tension likewise increased. Iridectomy upwards in this eye was made with a Graefe's knife, and after the healing the papilla was distinctly to be seen; it exhibited a deep pressure excavation without vessels, and had to its outer side a crescent-shaped atrophy of the choroid. That this could not be observed before, even through a moderately-dilated pupil, must be attributed, at least in part, to the diffuse opacities in the vitreous accompanying the glaucomatous process. The eye now counts fingers eccentrically at from 6′ to 7′.

I have recently observed an interesting case in which a single instillation of atropine into the eyes, caused double acute glaucoma in an apparently healthy lady.

Mrs. C—, 64 years of age, had always enjoyed good sight up to the 17th of August, at which time, desiring to show a young girl suffering from conjunctivitis, how to apply a solution of zinc, she dropped into her own eyes, by mistake, a solution of atropine, which I had previously prescribed to her son for progressive myopia. From its effects vision was naturally somewhat blurred, yet on the second day she could see sufficiently to write a letter, but in the afternoon of that day she was attacked with a violent inflammation of both eyes, commencing on the left side, and accompanied by severe headache, repeated vomiting and marked dimness of sight. On the subsequent day the redness of the eyes was less but the diminution of sight was greater. On the 26th of August, I was called to see her and found double sub-acute glaucoma with the following phenomena :—Slight pericorneal injection, T + 1, pupils moderately dilated, ant. chambers shallow in both eyes. Fine maculæ cornearum centrales of old date and punctate opacities upon the front surface of the cornea. The refracting media were turbid, yet the ophthalmoscopic examination was still possible. In the left eye the papilla optica was neither totally nor deeply excavated but there was a jumping pulsation of all the principal arteries. In the right the outlines of the papilla were just to be observed and the arteries showed the same jumping pulsation. L. distinguished Jäg. 14 with difficulty ; right fingers only very near the eye. Limitation of the visual field on both sides as before.

She was immediately admitted and on the following morning I made, with a lance-shaped knife, double iridectomy downward. In the evening the tension was normal, the anterior chambers restored and the sight improved.

On the 28th, I found a slight adhesion of the edges of the coloboma to the ant. capsule. The question whether under these circumstances atropine, which was the cause of the acute attack, should be again employed was rather difficult to decide on account of the absence of positive information on this point.

But on the 29th, finding distinct posterior synechiæ in the right eye I instilled a solution of atropine, and there being no reaction and the physiological effects only moderate, in the evening I dropped the solution into both eyes. From this time forward the mydriatic was used as is customary after iridectomy for glaucoma. All the synechiæ tore, the longest to give way were at the edges of the sphincter.

The first ophthalmoscopic examination (Sept. 1st) revealed in the right eye four large blood extravasations upon the papilla and bordering retina and a small one near the macula; the periphery was normal. There were no hemorrhages in the left. The refracting media were clear (except a few radii in the lenses) and the jumping pulsation of the arteries had disappeared. There remained partial excavation of the papilla upon both sides; Tn.

On the 7th Sept., with + 6, S. L. = Sn. 2½; S. R. = Sn. 6½. Fingers were counted eccentrically upon all sides. Soon after, the left eye read Sn. 1½; the right Sn. 2½, a small persistent defect in the visual field prevented the patient from reading fluently with the right eye.

Among the cases of chronic glaucoma (Arch. f. Ophth. xv. 3, 202) that form which Graefe terms *glaucoma malignum* deserves the particular attention of the practitioner: first on account of its rarity (v. Graefe saw it only five times among several hundred cases); secondly on account of its sad termination—the regular operation hastening the loss of sight; and thirdly on account of our complete ignorance of its etiology and the conditions on which its unfortunate course depends, so that, before the operation, we cannot in general prognosticate this sad termination (v. Graefe, l. c., p. 208). It is certainly demanded that all hitherto known cases should be impartially published since increased knowledge of this affection may lead to the discovery of a remedy.

Mrs. H——, aged 51 years, a Jewess, came to me on the 17th of November, 1873, with the following history:—She had had disease of the chest for several years, and complained of headache and a difficulty of working for any length of time. In April, 1873, she first perceived obscurations before the left eye. These continuing in September with an increased diminution of vision, she was operated upon in one of our best ophthalmic institutions, nevertheless sight was completely lost, and two days subsequently cloudiness of the other eye set in. A paracentesis was made and followed by temporary relief. It was repeated, but two weeks later the power of vision was so poor that the patient could not find her way about.

St. Præs. The left eye is amaurotic. There is slight pericorneal injection and a marked development of the episcleral veins. T + 1. I made iridectomy upwards, the wound healed smoothly and without any

adhesions of the iris. The ant. chamber was empty, the lens transparent, the papilla excavated, and the corp. vit. cloudy.

The right eye still counts fingers at 6′ to 8′ (with a high degree of concentric limitation of the visual field). The pupil is somewhat dilated and quadrangular in shape, and the ant. chamber is very shallow. There is a deep pressure excavation without spontaneous pulsation of the arteries. Tension somewhat increased.

Although here the diagnosis of glaucoma malignum appeared evident, I resolved after mature reflection upon operating, for, by a spontaneous course, the remaining sight of the right eye must surely be lost within a short time ; further it is not yet decided whether the malignancy of the affection belongs to one eye only or the individual—in other words whether malignant glaucoma is always double-sided. From renewed paracentesis, already twice made in vain, I could expect no great advantage considering the rapid decay of the visual power, and, further, the possibility that in severe cases repeated punctures may also cause a baneful termination. For these reasons, on the forenoon of the following day, when her sight was already so poor that she could not find her bed without difficulty, I made an iridectomy upwards with a glaucoma lance, and, bearing in mind V. Graefe's supposition of a probable irritation of the corp. cil. in these cases, I made the incision as little peripherically as possible. The operation was completely normal, and technically considered, was satisfactory throughout. It was somewhat surprising that the iris did not prolapse, not even after pressure upon the scleral wound, but had to be drawn out with the forceps. Though no hemorrhage ensued, the eye could not see to count fingers held before it. Upon gentle palpation there was T + 1, which was somewhat higher than the day previous and incomparably greater than is usual after this operation. The bandage was only lightly applied. In the morning photopsies continued with a shallow ant. chamber, T < + 1. The following day (Nov. 19th) the iris was seen pressed against the cornea and there was some pericorneal injection, otherwise no irritation, but an entire absence of pain ; T + 1. On the 20th there being still no ant. chamber I made a venesection of ten ounces with the idea that the intra-ocular tension might perhaps be influenced by lowering the general blood pressure. The next day the indications remaining, my colleague, Dr. Eulenburg, kindly applied galvanization by means of a transportable apparatus, to the sympathetic nerve in the neck. All this was of no effect. From this time we had to abstain from further therapeutical measures. I had the intention of repeating the galvanization and of making a paracentesis of the sclerotic and permitting a drop of vitreous to escape, but the

patient peremptorily objected to further procedures. Being for years possessed of the idea that she was destined to become blind, she considered all attempts to arrest or postpone this termination as fruitless. All persuasions being in vain, she remained with a well-healed cicatrix, no ant. chamber and loss of sight.

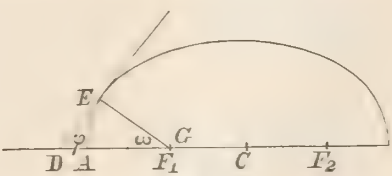
I believe this sad case is instructive, the more so since both eyes were operated upon by two different persons. Having communicated the facts as they are I will abstain from further remarks.

A CONTRIBUTION TO THE CALCULATIONS IN OPHTHALMOMETRY.

By Dr. J. HIRSCHBERG, of Berlin.

(Translated by Dr. F. A. Munson, of Albany, N. Y.)

As Woinow's "Ophthalmometrie" has found a considerable circulation among oculists who wish to enter thoroughly into this subject, without being able to follow the difficult mathematical investigations in Helmholtz's original works (Arch. f. Ophthalm. I. 2, and Physiol. Optik), I would briefly point out that in Woinow's brochure, aside from its imperfection of style and a few small mathematical errors, there remains an important omission,* namely, the derivation of the *fundamental formula for the determination of the radius of curvature of any point of an ellipse*; a derivation which to those who would furnish scholia, so to speak, for medical men on a physico-mathematical investigation of Helmholtz, must be considered of more importance than long calculations according to this fundamental formula.



Helmholtz (Arch. f. Ophth. I. 2, 18, etc.) says:

If ω indicates the angle which the plumb-line of a given point of an ellipse forms with the great axis, a the great half-axis, ε the numerical eccentricity $= \frac{a}{c}$, then the radius of curvature of this point of the ellipse is

$$\varrho = \frac{a(1-\varepsilon^2)}{(1-\varepsilon^2 \sin^2 \omega)^{\frac{3}{2}}}$$

* In the clear and comprehensive exposition of Ophthalmometry by Mauthner (Die optischen Fehler des Auges, p. 02) only the results of the calculation are given.

DEMONSTRATION.

I.) *Analytical.*

For each curve, of which the differential is represented by ds

1) $\varrho = \frac{ds}{d\varphi} = \frac{ds}{dx} \cdot \frac{dx}{d\varphi}$, and

2) $\operatorname{tang} \varphi = \frac{dy}{dx}$.

3) $\frac{dx}{ds} = \cos \varphi = \sin \omega$, since $\omega = 90^\circ - \varphi$; for this reason $d\omega = -d\varphi$.

Consequently 1a) $\varrho = -\frac{1}{\sin \omega} \cdot \frac{dx}{d\omega}$. Furthermore we note

4) $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, which is the equation for the centre of the ellipse.

From 4) it follows $\frac{xdx}{a^2} + \frac{ydy}{b^2} = 0$, consequently

$$\frac{dx}{dy} = \frac{1}{\operatorname{tang} \varphi} = \operatorname{tang} \omega = -\frac{ya^2}{xb^2}, \text{ therefore}$$

5) $y = -\frac{b^2 x \operatorname{tang} \omega}{a^2}$. Consequently from 4)

6) $\frac{x^2}{a^2} + \frac{x^2 b^4 \operatorname{tang}^2 \omega}{a^4 b^2} = 1$ or $x^2 = \frac{a^4}{a^2 + b^2 \operatorname{tang}^2 \omega}$. Thence from 5)

7) $y^2 = \frac{a^4}{a^2 + b^2 \operatorname{tang}^2 \omega} \cdot \frac{b^4 \operatorname{tang}^2 \omega}{a^2} = \frac{a^2 b^4 \operatorname{tang}^2 \omega}{a^2 + b^2 \operatorname{tang}^2 \omega}$

By differentiation we obtain from 6

$2xdx = -\frac{2a^4 b^2 \operatorname{tang} \omega \, d\omega}{(a^2 + b^2 \operatorname{tang}^2 \omega)^2 \cos^2 \omega}$, consequently when the value of x is substituted from 6

$$\frac{dx}{d\omega} = -\frac{2a^4 b^2 \operatorname{tang} \omega}{(a^2 + b^2 \operatorname{tang}^2 \omega)^2 \cos^2 \omega} \cdot \frac{\sqrt{a^2 + b^2 \operatorname{tang}^2 \omega}}{2a^2}.$$

8) $-\frac{dx}{d\omega} = \frac{a^2 b^2 \operatorname{tang} \omega}{(\cos^2 \omega)\ (a^2 + b^2 \operatorname{tang}^2 \omega)^{\frac{3}{2}}}$

Now from 1a) we find

$$\varrho = \frac{1}{\sin \omega} \cdot \frac{a^2 b^2 \operatorname{tang} \omega}{\cos^2 \omega.\ (a^2 + b^2 \operatorname{tang}^2 \omega)^{\frac{3}{2}}} = \frac{a^2 b^2}{(\cos \omega)^{\frac{6}{2}}\ (a^2 + b^2 \operatorname{tang}^2 \omega)^{\frac{3}{2}}}$$

$$\varrho = \frac{a^2 b^2}{(a^2 \cos^2 \omega + b^2 \sin^2 \omega)^{\frac{3}{2}}} = \frac{a^2 b^2}{(a^2 - (a^2 - b^2) \sin^2 \omega)^{\frac{3}{2}}}$$

$\varrho = \frac{a^2 . a^2 (1 - \varepsilon^2)}{a^3 (1 - \varepsilon^2 \sin^2 \omega)^{\frac{3}{2}}}$, as $a^2 - b^2 = \varepsilon^2 a^2$ and $b^2 = a^2(1 - \varepsilon^2)$.

9) $\varrho = \frac{a(1 - \varepsilon^2)}{(1 - \varepsilon^2 \sin^2 \omega)^{\frac{3}{2}}}$ Q. E. D.

II.) *Elementary.*

In order to give briefly the calculation, I quote from the well-known text-book of Analytical Geometry of Fort and Schlömilch.

1) $\frac{x_1^2}{a^2} + \frac{y_1^2}{b^2} = 1$, which is the equation for any given point E in the ellipse whose co-ordinates are x_1 and y_1 (l. c., p. 81).

2) $\text{tang}\ \varphi = -\frac{b^2x_1}{a^2y_1}$ (l. c., p. 128).

3) $\varrho = \frac{u^3}{p^2}$, where $p = \frac{b^2}{a}$ and u (the normal) $= \frac{b}{a}\sqrt{a^2 - \varepsilon^2x_1^2}$ (l. c., pp. 143 and 131).

From 3 follows 3a:

$$\varrho = \frac{b^3}{a^3}\left(\sqrt{a^2 - \varepsilon^2x_1^2}\right)^3 \cdot \frac{a^2}{b^4} = \frac{1}{ab}(a^2 - \varepsilon^2x_1^2)^{\frac{3}{2}}.$$

From 2 follows: $1 + \text{tang}\ ^2\varphi = \frac{1}{\cos^2\varphi} = \frac{a^4y_1^2 + b^4x_1^2}{a^4y_1^2}$, consequently

4) $\cos^2\varphi = \frac{a^4y_1^2}{a^4y_1^2 + b^4x_1^2}$. Substituting for y_1 its value found in 1), we have

$$\cos^2\varphi = \frac{a^2b^2(a^2 - x_1^2)}{a^2b^2(a^2 - x_1^2) + b^4x_1^2} = \frac{a^4 - a^2x_1^2}{a^4 - (a^2 - b^2)x_1^2}$$

4a) $\cos^2\varphi = \frac{a^2 - x_1^2}{a^2 - \varepsilon^2x_1^2}$, because $a^2 - b^2 = a^2\varepsilon^2$. Here we find

5) $x_1^2 = \frac{a^2\sin^2\varphi}{1 - \varepsilon^2\cos^3\varphi}$. It is therefore in 3a that

$$a^2 - \varepsilon^2x_1^2 = a^2 - \frac{\varepsilon^2a^2\sin^2\varphi}{(1 - \varepsilon^2\cos^2\varphi)} = \frac{a^2 - a^2\varepsilon^2(\sin^2\varphi + \cos^2\varphi)}{1 - \varepsilon^2\cos^2\varphi} = \frac{a^2(1 - \varepsilon^2)}{1 - \varepsilon^2\cos^2\varphi}.$$

Hence from 3a we have

$$\varrho = \frac{1}{ab}\left(\frac{a\sqrt{1 - \varepsilon^2}}{\sqrt{1 - \varepsilon^2\cos^2\varphi}}\right)^3 = \frac{a^3\sqrt{1 - \varepsilon^2}.(1 - \varepsilon^2)}{a.a\sqrt{1 - \varepsilon^2}.(\sqrt{1 - \varepsilon^2\cos^2\varphi})^3} = \frac{a(1 - \varepsilon^2)}{(\sqrt{1 - \varepsilon^2\cos^2\varphi})^3}$$

$$\varrho = \frac{a(1 - \varepsilon^2)}{(1 - \varepsilon^2\sin^2\omega)^{\frac{3}{2}}},$$ since $\cos\varphi = \sin\omega$.

The further reckoning, according to this formula, may be easily done by every one who takes an interest in it. It is simpler than would appear from Woinow's calculation (l. c., p. 42–45).

ON THE COEFFICIENTS OF REFRACTION OF THE FLUID MEDIA OF THE HUMAN EYE.

A Paper read before the "Berliner Physiologische Verein."

By DR. J. HIRSCHBERG, Lecturer at the Berlin University.

(Translated by Dr. Geo. W. Rachel, of New York.*)

THERE are three different series of facts which it is necessary for us to know when we attempt to follow the rays of light on their way through the human eye, viz.:

1) The curvature of each surface, separating two of the media with different power of refraction.

2) The distance of these different surfaces from some fixed point of the ocular axis (or from the surface of the retina).

3) The indices of refraction of the different media.

It is of the indices of refraction that I shall treat in this paper.

The values found for the indices of refraction during the first half of the present century were not exact; nor were the investigations extensive, since each observer examined only very few eyes. Still the results agreed so well that Prof. LISTING, in his celebrated treatise, "Dioptrik des Auges" (1851), was able to give as an average number: $\frac{103}{77} = 1.34$ for the index of refraction of both aqueous and vitreous humors. BREWSTER'S method is the one that deserves a special mention. He interposed the substance to be examined between the convex surface of the objective of a microscope and a plain glass plate, perpendicular to the axis of the instrument; he then determined the distance between object and objective before and after interposing the substance to be examined, and also when distilled water was interposed. The index of refraction of water being known, the measurements taken sufficed to determine the index of refraction of the intraocular fluids.

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* A preliminary communication on this subject was made in No. 13 of the *Med. Centralblatt* of 1874.

Somewhat later, Prof. W. KRAUSE made very extensive, and Prof. H. HELMHOLTZ very accurate measurements.*

KRAUSE, according to the directions given by CAHOURS and BECQUEREL, determined the size of the microscopical image of an object, having first air in a small chamber situated between the convex surface of the objective and a plain glass plate; secondly, distilled water; and thirdly, vitreous or aqueous humor in the same.

If the different sizes of the image are β_1, β_2, and β_3, if n is the exponent of refraction of distilled water for the strongest part of the spectrum ($=1.3342$), the coefficient of refraction is found by the formula:

$$N = 1 + (n-1)\,\frac{\beta_1 - \beta_3}{\beta_1 - \beta_2}$$

The average thus found was, for aqueous humor 1.3420, and for vitreous 1.3485.

This method cannot be called very exact, since the individual differences amounted to 0.02, while in both aqueous and vitreous, as we shall presently see, the index of refraction is constant as far as the third decimal.

HELMHOLTZ inclosed small quantities of the fluids to be examined between the concave surface of a plano-concave lens and a plain glass plate, and measured with the ophthalmometer the size of the images of a known object, as produced by this system; he also determined, in the same way, the radius of the concave surface of the lens, and by these means he calculated the index of refraction.

He found it to be,

For the aqueous, 1.3365.
For the vitreous, 1.3382.

The usual method of physicists for the direct determination of the index of refraction of fluid substances is not applicable to the fluids of the human eye. It is done by finding the minimum of deflection of light of a certain color, produced by a hollow prism filled with the fluid to be examined. Even if aqueous humor,

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* Die Brechungsindices d. durchsichtigen Medien d. menschl. Auges. Von Dr. W. Krause, Hannover, 1855. Helmholtz, Physiol. Optik., p. 78.

obtained from different individuals, should be mixed together, which could certainly not be called an exact procedure, as there must be individual differences,—even then, it would be impossible to have an abundant supply of sufficiently fresh material. Furthermore, the application of this method is by no means easy, and requires very delicate and correct instruments.

The method devised by Prof. ABBÉ of Jena some years ago and lately fully described* will be of great advantage if applied to these investigations, as it will be to many others.† It enables the experimenter to determine rapidly, with ease, and at the same time correctly, the exponent of refraction of a minute quantity of fluid. It is only necessary to ascertain the angle of total reflection between glass and the fluid to be examined ; this angle has a very simple relation to the index of refraction.

If a beam of light AB, passed from the medium 1, with the absolute coefficient of refraction n, into the, optically speaking, denser medium 2, with the coefficient of refraction ν, we have :

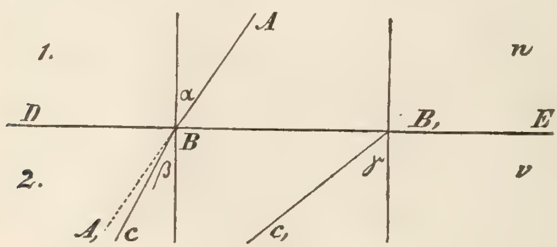


FIG. 1.

$$\frac{\sin \alpha}{\sin \beta} = \frac{\nu}{n} ;$$

* Neue Apparate zur Bestimmung des Brechungs- und Zerstreuungsvermögens fester und flüssiger, Körper. Jena, 1874.

† The exponent of refraction of a solid body depends on its chemical constitution and that of a solution on the degree of its concentration ; it may therefore be used to determine both. The method, described by ABBÉ will certainly be of great importance to medical men in regard to the examination of urine, vaccine-matter and various other solutions. For it is the simplest method of all and at the same time the most easily executed.

since $\frac{\nu}{n}$ represents the ratio of refraction, obtaining on the passage from 1 to 2. The angle α may assume any size from 0° to 90°; but β must always be smaller than α, since we have the hypothesis that $n < \nu$. If α reaches its maximum $= 90°$, *i. e.*, $\sin \alpha = 1$, β will attain its limit $= \gamma$; therefore:

$$\frac{1}{\sin \gamma} = \frac{\nu}{n} \text{ or: } n = \nu. \sin \gamma;$$

If, therefore, a beam of light, CB_1 passing through the second medium, strikes the surface BB_1, separating the two media, so that it forms with the latter the critical angle γ, it will be transmitted in the direction B_1E; if it forms an angle with BB_1 which is $> \gamma$, it cannot at all pass into the first medium; on the contrary, it is totally reflected. If now the index of refraction of the denser medium ν is known, and if the critical angle γ has been determined by experiment, the unknown quantity n is found by substituting the values of ν and γ in the foregoing equation. The value of γ may be found in two different ways:

1) If the direction of the beam of light be known, the separating surface may be slowly turned until the reflected beam attains its *maximum of intensity*. The fundamental experiment may be made with any rectangular prism. On the surface, corresponding to the hypothenuse of the cross-section, a drop of water is to be placed, and then such a position must be given to the prism that this surface is turned horizontally downwards, it being movable on an axis parallel to the anterior edge, *i. e.*, the edge formed by the horizontal side and that side corresponding to one of the cathets which is directed towards some source of light. If we are looking on the surface, corresponding to the other cathet and the prism is slowly turned, the drop of water adhering to the surface, directed downwards, will at a certain moment become invisible, viz.: when the beam of light, refracted from the anterior surface, forms with the surface, corresponding to the hypothenuse the greatest angle possible between glass and water.

It is a well-known fact that *Wollaston* has taken advan-

tage of this method in order to determine the index of refraction of different substances; it is, however, not very exact; in the first place, because it is impossible to form a perfectly accurate judgment about the very moment of brightest reflection, and in the second place, because the beam of light under observation constantly changes its relation to the separating surface. Still we have to make use of *Wollaston's* method for determining the indices of refraction of the human *lens*, because for this substance, on account of its physical constitution, *Abbé's* method is not applicable, as I shall endeavor to show hereafter.

2) According to the second method (*Abbé's*) the critical angle γ is determined by observing at what time a beam of light passing through the two media, reaches its *minimum of intensity*, *i. e.*, when it disappears entirely from view. This, in the first place, may be determined with perfect accuracy, as the difference between a small quantity and absolute absence of light is easily appreciated; it may, in the second place, be applied in a very simple manner, because the beam passing through the prism can be given a constant direction. It is only necessary to include a thin layer of the fluid to be examined between two identical rectangular prisms, which are in apposition with the two surfaces corresponding to the hypothenuses of their base and which have a greater power of refraction than the substance investigated.

Such a combination acts as if it were a plano-parallel surface, and causes the *beam of light entering it to emerge absolutely without changing its direction*, if it can emerge at all.

The anterior and posterior surfaces, *ON* and *PQ* (Fig. 2), of the intermediate layer (liquid) are parallel, and therefore also their perpendiculars, $c_1\, c_2$ and $d_1\, d_2$ are parallel, and inclose with the beam of light *CD* the angle δ; in the anterior prism, the ray of light forms the angle γ, in the posterior the angle γ_1 with the perpendiculars to the opposed surface; then, according to the fundamental law of refraction, we have

$$\left.\begin{aligned} \sin \gamma &= \frac{n}{\gamma} \sin \delta \\ \text{and } \sin \gamma_1 &= \frac{n}{\nu} \sin \delta \end{aligned}\right\} \text{therefore: } \gamma = \gamma_1, \text{ since both are } < 90^\circ.$$

Consequently $BC \# DE$.

With the perpendicular to the surface MO of the anterior prism, let the beam inclose the angle β, with that of QR the angle β_1; let also: $\sphericalangle MON = \sphericalangle PQR = w$;
Then, we have:

$$\beta = \gamma - w;$$

since in the $\triangle OBC$:

$$(90^\circ - \gamma) + (\beta + 90^\circ) + w = 180^\circ.$$

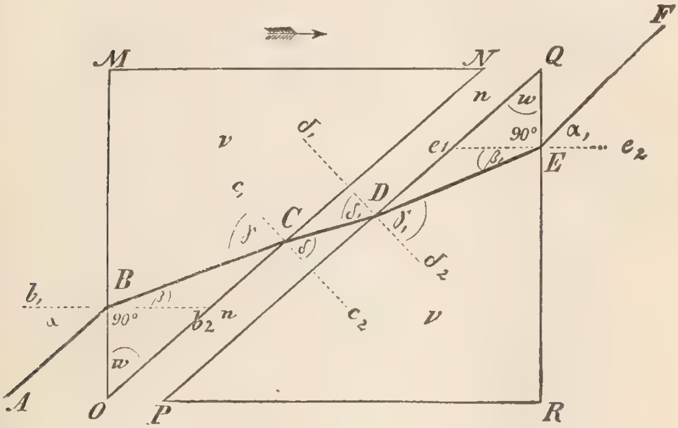


FIG. 2.

But, for similar reasons

$$\beta_1 = \gamma - w;$$

therefore:

$$\beta = \beta_1;$$

The original angle of incidence be α, the angle of emergence α_1; then,

$$\sin \alpha = \nu \sin \beta;$$
$$\sin \alpha_1 = \nu \sin \beta;$$

therefore

$$\alpha = \alpha_1;$$

The foregoing conclusions prove that

$AB \ddagger EF$; Q. E. D.

The beam cannot emerge at all, however, if γ is equal to, or greater than, the critical angle. To find the index of refraction, we now have the following simple equations:

$$1)\ \sin \beta = \frac{1}{\nu} \sin \alpha$$
$$2)\ \gamma = \beta + w;$$
$$3)\ n = \nu \sin \gamma;$$

If the constant quantities of the prism apparatus, ν and w, are known, it would only be necessary to determine that angle of incidence α, simultaneously with which γ reaches its limit.

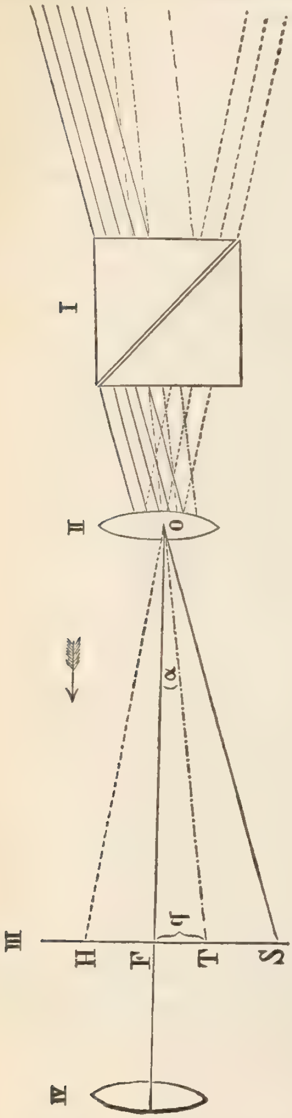


Fig. 3.

In order to determine α more easily, the combination is connected with a small telescope; in the focal plane of the objective there is an opaque diaphragm which has a narrow vertical, transparent slit, bearing a micrometer scale, and corresponding to the median principal section of the prisms.

Let I in Fig. 3 represent the two prisms, II the objective of the telescope, III the slit in the focal plane, and IV the eye-piece. The direction of the rays of light is indicated by an arrow.

At S, the lowest point of the slit, only those rays can be collected which form in front of the objective a pencil of parallel rays of the direction OS; in T only those rays are united which before to the objective are parallel to OT; in the centre F, only those which in front of the objective are parallel to the axis of the telescope; in H, a higher point, only those which are parallel to OH before the objective.

Those rays which impinge upon the anterior surface of the prism-combination in the direction of the axis of the telescope form a certain angle, γ_1 (Fig. 4) at the anterior surface of the liquid; a parallel pencil which in front of the prisms, is inclined upward toward the axis, forms a smaller angle γ_2; one, however,

that is inclined in a downward direction, forms a larger angle γ_3. According to the value of the index of refraction of the fluid under observation a certain pencil is totally reflected, and it is that pencil which forms the critical angle γ at the interposed layer of fluid. All pencils, forming a larger angle, are extinguished. If for instance T in Fig. 3, is that point of the slit where the critical pencil is collected, the slit will appear dark above and light below this point T; the boundary between dark and light will be very distinct for monochromatic light. The distance between T and

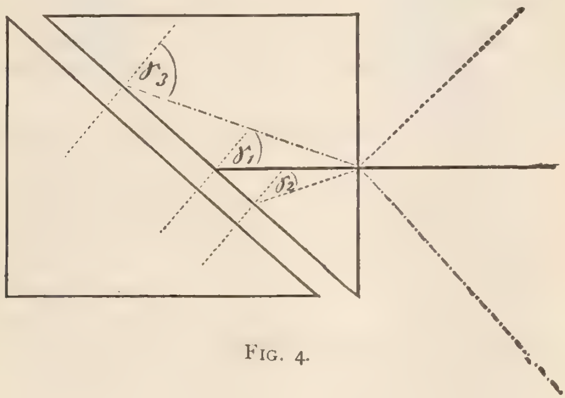


FIG. 4.

the axis of the telescope can be correctly ascertained; $TF = q$; if p is the known focal distance OF of the objective, we have:

$$\frac{q}{p} = \text{tang}\ \alpha.\ (\alpha < 90^\circ);$$

the angle of incidence α, with which total reflection commences may thus be found; and the above equations (1–3) give us all the data required to calculate the index of refraction of the substance under examination.

Matters are, however, somewhat different, if other than monochromatic light is used—for instance, white light of different directions when the apparatus faces the sky. The index of refraction, and therefore also the critical angle, are different for rays of different colors travelling in the same direction. If the limit has been found for the rays of the greatest intensity, corresponding

in the spectrum to Frauenhofer's line D, the limit will have been transgressed for violet light, because of its being more refrangible, although it formed the same angle of incidence; it also is extinguished. But the limit has not been reached for red light, which, being less refrangible, is transmitted. Below the line separating light and dark, a rim of red-color is therefore visible. This, being an obstacle for accurate adjustment, has to be removed, which can be accomplished by interposing between the two prisms and the objective of the telescope a small prism *à vision directe*—which has the property of leaving the direction of the rays of the refrangibility of D unchanged, but deflecting the others correspondingly. The little dispersion produced by the prism *à vision directe*, neutralizes the colored rim caused by the total reflexion.

While an ordinary prism II (Fig. 5) deflects an infinitely narrow

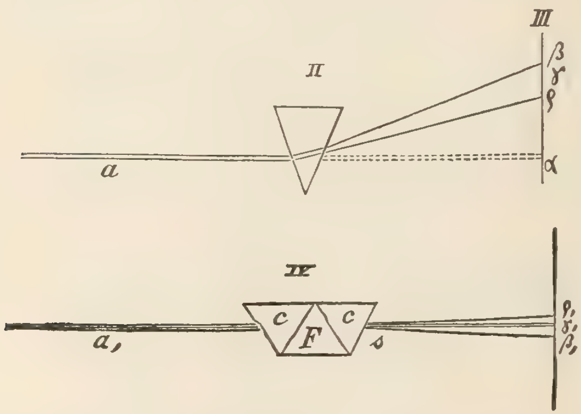


FIG. 5.

pencil of parallel rays of mixed light a in such a manner that it strikes the screen III not in α but in $\beta\varrho$, β denoting the site of the more refrangible (blue and purple), ϱ that of the red rays; a prism *à vision directe* IV (composed of one flint and two crown-glass prisms, or two flint and three crown-glass prisms), leaves the direction of the yellow light contained in the parallel pencil of mixed light a_1 unchanged, so that γ_1 a_1 is a straight line,

but deflects the red light contained in the same pencil to β_1, the purple light to ϱ

In order to render the effect of such a prism in our case more intelligible without any calculation, suppose that *I* (Fig. 6) be the micrometer slit of the apparatus before the interposition of the compensating prism and *II* the same after the latter has been interposed.

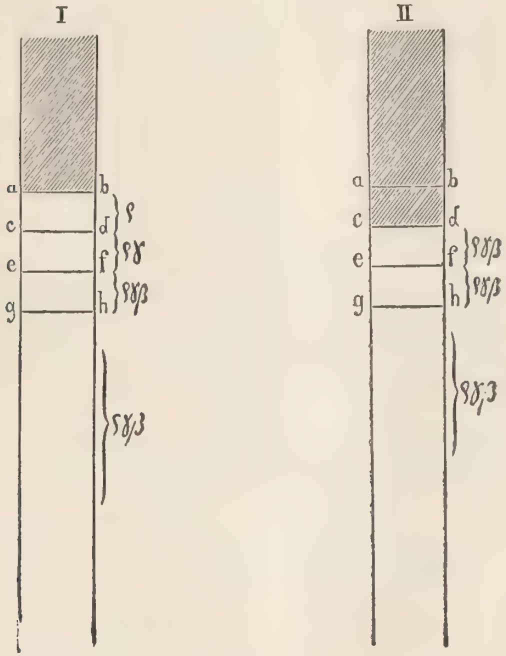


FIG. 6.

Let in *I* no light be visible above *ab*, between *ab* and *cd* red only, between *cd* and *ef* red and yellow, so that *cd* represents the bordering line of the yellow light; between *ef* and *gh* let there be yellow, red, and purple, *i. e.*, mixed white light, and the same, of course, below *gh* down to the lower angle of the slit. Suppose the prism *à vision directe* leaves the direction of yellow light unchanged, but throws the red light upward, the purple light downward, both by the breadth of a rectangle (since the prism *à vision directe* is placed before the objective of the telescope, it

must deflect the red light upward and the purple downward). Then the red light will disappear from *abcd* in *II.* The rectangle *cdef* which gives its red light to the one below, retains its yellow, receives red from above and purple from below ; it therefore appears white, as does the whole space of the slit below. *The line separating dark from light, being now a chromatic, coincides exactly with the original boundary* cd *of the yellow light.*

To the bordering line *cd* corresponds the critical angle of light of the refrangibility of Frauenhofer's line D. The index of refraction of the fluid under examination calculated from these data, is thus determined in a very precise manner, it refers to light of the above quality.

Since the dispersion due to the different fluids to be examined is a different one for each, the dispersion caused by the compensating prism must also admit of an alteration. To this end it must be capable of being turned so that its principal cross-section forms with the cross-section of the double prism any angle Z between 0° and 360° or at least 180°. The deflection δ, which the compensating prism gives to a certain kind of light, for instance to red light, is primarily measurable by an angle (Fig. 5),

$$\delta = \varrho_1 \varsigma \gamma' ;$$

but it may also be measured by a linear quantity K, if the distance *e* between the screen and the prism is given.

$$\gamma_1 \varrho_1 = \mathrm{K} = \mathrm{e} \text{ tang } \delta$$

If, now, the angle formed by the principal section of the double prism is Z, the deflection caused in the latter is :

$$\mathrm{A} = \mathrm{K} \cos \mathrm{Z} ;$$

A glance at Fig. 7 will make this plain at once.

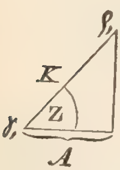


FIG. 7.

Since cos Z may be any quantity between + 1 and − 1, A may be any quantity between + K and − K, and therefore it always adapts itself to the dispersion of the fluid to be examined, if only K, *i. e.*, the compensating prism is of the suitable description.

After having thus explained the principles on which the experiments are based, it remains to speak of their execution. To this end I have first to describe the *apparatus* (Fig. 3). To the anterior surface of a short telescope one of the identical prisms is fixed with that surface corresponding to its lesser cathet. The

latter includes an angle of 64° with the hypothenuse. The second prism may be removed and fixed again tightly against the first by means of a spring. Between the two prisms and the objective of the telescope the compensating prism is placed in such a manner that it may be turned by means of a small handle. In the focal plane of the objective, a slit-like micrometer scale is placed, on which the boundary between dark and light indicates the coefficient of refraction to the thousandth. The apparatus ranges from 1.33 to 1.43, if crown-glass is used. To complete one mensuration, the one prism is taken off, both hypothenusal surfaces are carefully cleaned, two narrow strips of thin paper are placed at the upper and lower end respectively of the hypothenusal surface of the fixed prism ; in the centre of this same surface a drop of fluid is placed, and now the second prism is pressed closely against it. Then the instrument is taken with one hand and directed toward a lucid surface, the sky in daytime, a light globe of a lamp at night; the handle is turned until the line of separation is colorless, and the index of refraction may be read off. It is also necessary to note the temperature at the time of experimenting.

With this apparatus *Sigismund Fleisher* has carefully investigated the exponents of refraction of the fluids contained in the eyes of all the different classes of vertebrata ; the results he obtained he has published in his Inaugural Thesis (Jena, '72).

For human eyes he found

Aqueous, 1.3373, and Vitreous, 1.3369.

But no fresh material was at his disposal. One subject was examined 1½ day, another 3 days, still another 5 days, and two others even six days after death.

I, therefore, thought it not superfluous to make another series of investigations with this easy and exact method on fresh material.

I. *The lachrymal secretion* covers the anterior surface of the cornea as a capillary layer. Its index of refraction was determined at a temperature of 16° R. (68° F.) to be 1.33705, three different specimens giving exactly this result.

II. *Aqueous Humor.*

1) From a woman, 77 years old (subject fresh, still warm):

$$\left.\begin{array}{ll}\text{Right eye,} & 1.33705\\ \text{Left eye,} & 1.33799\end{array}\right\}\ 12^\circ\ \text{R. } (59^\circ\ \text{F.})$$

2) From a woman, 34 years old (subject fresh):

Right eye, 1.33705 }
Left eye, 1.33752 } 12° R. (59° F.)

3) From a new-born child (two days after death):

Right eye, 1.33865 at 12° R. (59° F.)

III. *Vitreous Humor.*

[at 12° R. (59° F.)]

1) From a woman, 29 years old (3 hours after death):

Right eye, 1.33588
Left eye, 1.33588

2) From a man, 22 years old (12 hours after death):

Right eye, 1.33588
Left eye, 1.33541

3) From a man, 30 years old (70 hours after death):

Right eye, 1.33635
Left eye, 1.33608

4) From a new-born child (48 hours after death):

Right eye, 1.33686
Left eye, 1.33798

These examinations were made with the more liquid part of the vitreous. In fresh eyes the average of the index of refraction amounts to 1.337 for aqueous, and 1.336 for vitreous humor.

CONTRIBUTIONS TO THE THERAPEUTICS OF CONJUNCTIVITIS DIPHTHERITICA.

By DR. J. HIRSCHBERG, of Berlin.

(Translated by Dr. R. Gebser, of New York.)

On January 19th a healthy young lady, twenty years old, consulted her family physician, Dr. Natanson. on account of a feeling of pressure in her right eye. The Doctor then noticed simple redness of the conjunctiva, but considerable swelling and secretion the following day. In the afternoon we found diffuse puffy swelling of both lids, copious sero-mucous discharge from the conjunctival cac, hard chemotic intumescence around the cornea, yellowish-red, elastic swelling of the whole conjunctiva, the parenchyma of which was suffused with blood, and hemorrhage on its surface readily occurred when the lids were cautiously everted. The pain was excessively severe, particularly upon pressure. The other eye was normal. The patient was free from fever, and, with the exception of the disease of the left eye, perfectly well.

The *diagnosis* was quite certain, all the symptoms of diffuse diphtheria conjunctivæ being present. The *etiology* of the disease, however, was obscure. The sporadic diphtheria conjunctivæ in adults, without constitutional symptoms, appears to me to derive its origin always from inoculation of virulent secretion. In this case the cause of contagion could be found neither in the patient nor in her surroundings. The mother suffered, in consequence of frequent confinements, from simple leucorrhœa. As it is a well-known fact that non-specific matter brought in contact with the conjunctiva is able to produce a severe inflammation even of diphtheritic character, it was thought possible that the young lady might have contracted her eye-disease while superintending the family washing, which she had done a short time previously.

The *prognosis*, of course, was serious, and consequently the treatment energetic. A protective bandage occluded the left eye. *Compresses dipped in ice water* were applied to the right eye, and changed regularly every minute; the discharge was removed from the palpebral fissure every quarter of an hour. In the evening six leeches were applied to the temple, and a dose of morphium administered. A nurse was in constant attendance day and night. On the following day the disease had in-

creased. The chemosis was harder, more prominent, and had spread so as to cover a considerable part of the cornea; the palpebral conjunctiva was infiltrated and whitish; this change was mainly noticed on the upper swollen reflection-fold and on the inferior cul-de-sac. Examination was difficult on account of severe pain which it occasioned. As the hard, wall-like chemosis appeared to us most dangerous, we scarified the conjunctiva of the eyeball with curved scissors; but only few drops of blood escaped. Now *compresses of tepid water* were applied until the evening, first, to keep up the after-bleeding, and secondly, because the disease had progressed in spite of the ice-applications; but the warm applications were relinquished, and ice-compresses employed again, since by experience their utility has been demonstrated, and they agreed decidedly better with the patient. As the still persisting chemosis rendered the suppuration of the cornea imminent, a treatment had to be adopted which was likely to favor the absorption of the dense infiltration; this treatment consisted in *rapid mercurialization.* After a second abstraction of blood from the temple a scruple of mercurial ointment was rubbed in every two hours, and half a grain of calomel was given internally at the same intervals. On the 22d day of January salivation commenced. The conjunctival discharge was copious and curdy, the cornea was hazy in its lower quadrant near the margin, the conjunctiva as before. The fact that three days after the beginning, without local treatment by caustics and astringents, the cornea participated spontaneously in the process proved the case to be a serious one, and invited a continuance of the mercurial treatment for another day. In the evening the salivation was very marked, the infiltration of the cornea had become an ulcer. On January 23d the ulcer was enlarged, and occupied the lower quarter of the cornea, and, being transparent, its edges could be distinguished only by oblique illumination; the chemosis was hard as before. The ice-applications were discontinued at intervals, and atropine was instilled. January 24th, the ulcer extending nearly over two-thirds of the cornea; its base was gray. On the following day it occupied fully two-thirds of the cornea; its centre was not yet bulging, but thinned. To preserve that large and endangered part of the cornea, the injurious influence of the increased pressure of the lids had above all to be removed; the canthus externus was divided with one stroke of the scissors. On the evening of the same day, the sixth day after the commencement of the disease, the process of elimination was first noticed in the upper reflection-fold, yet the conjunctiva was very rigid. On the the 26th, for the sake of experiment, I first cauterized the conjunctiva with a solution of acetate of lead, and on the following day with a solution of nitrate of silver, gr. viij. ad. ℥j. The condition of the

mucous membrane improved conspicuously, but now the danger of an extended ulceration of the cornea became more threatening. On the 28th a part of the base of the ulcer (a little above its centre), about three mm. in diameter, was convex, and became still more convex on the 29th. At the same time there were severe symptoms of irritation, the usual prodromi of rupture of the cornea. Although traumatic interference in conjunctivitis diphtheritica should be avoided as much as possible, yet in this instance it was almost certain that the inevitable perforation of the cornea, if allowed to take place spontaneously, would have rendered the whole base of the ulcer necrotic and destroyed the eye. An artificial opening of the anterior chamber in the thinnest place of the cornea was therefore absolutely indicated. We did not perform paracentesis, because the opening with a needle is too apt to close again, and a frequent repetition of the small operation, accompanied with the unavoidable injury to the diseased conjunctiva by the fixing-forceps, appeared inappropiate, but we made use of an *emetic*, composed of ipecac and tartar-emetic, having previously applied a compressive bandage to the eye.

The rupture took place as desired, and was noticed by the patient during the night between the 29th and 30th of January. On the 30th the convex part of the ulcer was flat and divided by a vertical rupture, the anterior chamber was empty, and the symptoms of irritation had disappeared. Every second day up to February 5th she was cauterized, then the discharge diminished to such a degree that a compressive bandage appeared sufficient to complete the recovery. This bandage was changed every three hours, later not so frequently, and whenever it was removed lukewarm compresses were applied for ten minutes, atropine instilled several times during the day, and rest on the back rigidly enforced. On the eighth day of February the vascularization from the margin of the cornea commenced. Thin radiating vessels extended from the conjunctiva, now no longer swollen, toward the centre of the cornea.

Very interesting, and at the same time very important for the preservation of the eye, was the action of the corneal fistula. From January 29th until February 19th, during two examinations a-day, the anterior chamber was either absent or only partially restored, and, therefore, the thinned cornea, being thoroughly at rest and not influenced by the intra-ocular pressure, could employ the material furnished by the newly formed blood-vessels for the restoration of its loss of substance.

Meantime a peculiar phenomena took place in the left eye. The protective bandage had been changed twice since the disease begun. On February 10th, the twenty-first day of the disease, when the secretion of

the right eye had completely ceased, there was a distinct conjunctivitis produced by pressure on the left eye. It never showed a diphtheritic character and disappeared after a few days.

In the right eye also the recovery was not effected without irritation. Toward the end of February the anterior chamber was closed, the centre of the cornea presented a large white spot, 2–3 mm. in diameter, which was nicely vascular on its surface, the vessels came from the margin and finally covered the speck in the centre with a dense scarlet layer; the other parts of the base of the ulcer were light grayish, pervaded by vessels; the whole region of the previous ulcer formed a facet-like depression. The pupillary margin showed broad adhesions with the central corneal speck, its upper part only was free, and yielded to atropine. A few days after the fistula had closed and normal tension was restored, an ominous symptom set in, namely, ciliary neuralgia. The examining finger could easily detect again an increase of pressure. Atropine was left off, but the increase of tension persisted. Periodic exacerbations of ciliary pain were very intense, a deep-violet redness surrounded the cornea, which protruded and became conical. The tension rose over $+ T_1$ — *secondary glaucoma* had developed, for which, on March 9th, an iridectomy was agreed upon at a very early state indeed, and before the cicatrization of the ulcer, which was the cause of the glaucoma, had been terminated. An observation, made by me not long previously, principally led me to this decision.

A young nurse in a city hospital, having been infected by a child suffering from blenorrhœa, had acquired a very severe conjunctivitis. She was attended to at once, and already three months after the beginning of the disease iridectomy was performed on both eyes. I saw the patient later on account of an injury of the eye. With the left eye she read fine print; with the right she counted fingers at $1\frac{1}{2}'$ only; this eye showed a deep glaucomatous excavation of the papilla optica. With such a rapidity, even in young persons, glaucoma may follow the formation of leucoma adhærens.

On March 10th, without administering a narcotic, I performed an upward iridectomy with a Graefe's cataract-knife. The ciliary neuros disappeared completely; the recovery was perfect. A week after, she read large print (Sn IV.) and counted fingers at 9′. On July 30th, *status idem.*

A CASE OF CONGENITAL SYMMETRICAL DEFECT OF BOTH CRYSTALLINE LENSES.

By Dr. H. BRESGEN, of Creuznach, Prussia.

(Translated by Dr. F. A. Munson, of Albany, N. Y.)

John S., from C——, 15 years of age, consulted me on account of his nearsightedness. He had myopia $\frac{1}{6}$ in both eyes, with $S = \frac{20}{20}$, and range of accommodation $= \frac{1}{3}$. There was no astigmatism present. By ophthalmoscopic illumination through a moderately dilated pupil I discovered around the lower margin of the pupil and in the lens a dark line, convex upwards. With a widely dilated pupil there was seen situated in the inferior part of the lens a symmetrical defect in both eyes, which was limited by the above-mentioned convex line, and extended to the border of the lens. The contour of the defective part at the point of greatest convexity corresponded to the thickness of the lens at that place, and became smaller on both sides analogous to the reduction of the lens toward its edge. Otherwise the lenses were normal in situation and continuity. There was no tremulousness of the iris at any point, and with transmitted light the entire pupil appeared red, but interrupted by a dark curved line. In the inverted image with the appropriate position of the glass lens, the papilla was to be seen double.

In all other respects the eyes were normal. The shape of the head was somewhat remarkable. The transverse diameters of the forehead and parietal regions were very small, and the region of the frontal and sagital sutures showed a crest-like projection.

A CASE OF MYOSIS CAUSED BY PARALYSIS OF THE LEFT SIDE OF THE CERVICAL PORTION OF THE SYMPATHETIC, IN CONSEQUENCE OF A GUNSHOT-WOUND.

By GEO. REULING, M.D., of Baltimore, Md.

In the year 1866 an officer of the army, Captain McC., was shot through the left side of his neck. The bullet entered the neck about two inches above the clavicle, immediately behind the anterior belly of the sterno-cleido-mastoid, and passed out about half an inch higher up at the anterior edge of the platysma myoides. During the two following years the gentleman sank rapidly in consequence of small purulent formations along the course of the sheath of the sterno-cleido-mastoid, as well as because of a pharyngeal soreness, which was greatly heightened at every attempt at deglutition, amounting at times to a spasmodic seizure. The patient had been pronounced by his medical attendants a hopeless consumptive, when one day a little piece of cloth belonging to the coat-collar which had formerly been penetrated by the bullet made its appearance through the open wound, which very soon afterwards became scarred over, and the patient grew visibly stronger. Being put on a liberal nutritious diet, and having had the benefit of a voyage by sea to Key West, he recovered completely, so much so, indeed, that he undertook the management of a farm.

In the year 1868, while cicatrization was going on, he for the first time noticed shooting pains in the arm of the affected side, radiating especially from the little finger. At first these pains appeared only after great exertions, or in consequence of a "cold," but in the Fall of 1869 the neuralgia became of daily recurrence and great severity. At the same time the patient was aware of a new symptom, a myotic condition of the left eye (of sudden occurrence), and accompanied with lancinating pain. He then came to me for advice.

Stat. præs. The patient is a wiry though muscular man, 36 years of age. At the left side of his neck the characteristic scar is seen running in the before-mentioned direction. Immediately above and below the clavicle, and partly in contact with it, there are three separate distinct

scars of the formerly fistulous openings. The neck is somewhat constrained in its movements—the head cannot very readily be turned to the right, and is a little directed to the left side in consequence of a slight shortening of the skin and muscles. The affected arm differs in nothing from the healthy arm, neither in development, structure, or temperature. In following the course of the nerves of the arm, however, and pressing tightly with the thumb, a well-marked point douleureux is met with over the rotula of the ulnar-nerve, as well as near the insertion of the pectoralis major into the humerus—symptoms which point to a neuralgia consequent upon pressure exerted by means of cicatricial formations on branches of the brachial plexus.

The left eye differed materially from the right, the pupil being contracted to the size of a pin's head. Not only was this the case, but the pupil was turned somewhat awry in its direction from below and inward to above and outward; light had no influence whatever upon it; it remained motionless. Neither its size nor its form was affected by the direct light transmitted by the sun, nor when that light was intercepted by the hand being placed before the eyes. That the pupil was contracted to its maximum extent was shown by the fact that the calabar bean could cause it to contract no further. $S = \frac{20}{200}$, with $- \frac{1}{18} = \frac{20}{20}$. At a distance of 3″ the finest writing could be read, although the patient declared that he could read only a few words at a time. When he held the eye steady and looked at larger objects he could discern only portions of them, the field of vision showing a considerable concentric limitation.

After a one-grain solution of atropia had been instilled and the pupil of the affected eye had, after the lapse of half an hour, enlarged to the diameter of the normal pupil on the right side, a healthy state of the internal structures, with the exception of slight hyperæmia of the choroid and retina, was discernible.

If now we sum up the various points of this interesting case, our diagnosis will be: paralysis of the cervical portion of the sympathetic caused by the gradual contraction of the cicatrix left after a gunshot-wound.

My treatment consisted in instilling a solution of atropia twice a-day for several weeks, as well as in the application of the continued current to the sterno-mastoid and along the course of the ulnar nerve.

Despite the little hope of success I entertained, since the cause of the suffering was permanently present, the neuralgic pain abated in frequency and violence already after two days. The effect of the atropia, which, in the first few days disappeared after six or eight hours, became of the usual duration from the sixth day. As soon as this much was accomplished, I prescribed the ungt. cinereum to be made into an

inunction with the extract of hyoscyamus, and had it rubbed into the scar. Every fifth day I applied one of Heurteloup's artificial leeches to do away with the hyperæmic state of the choroid. After he had been three weeks under treatment I was enabled to discharge the patient, into whose eye I had not, for the last week, instilled a drop of atropia, with a view of noting the state of the pupil. The gentleman left me with a pupil of nearly the normal size, and visual power but very slightly impaired, $S = \frac{20}{30}$, with $-\frac{1}{40} = \frac{20}{20}$.

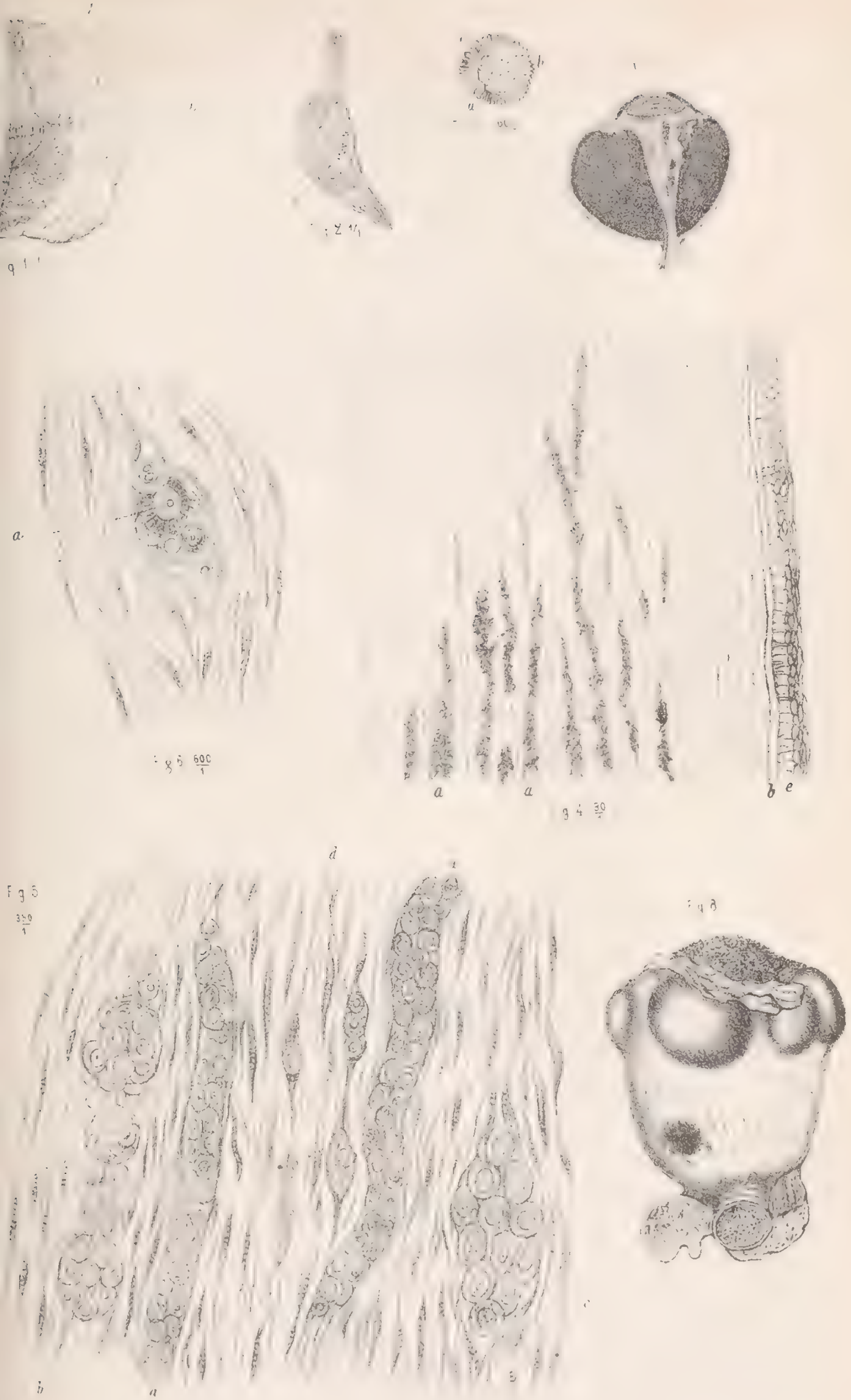


Fig. 5
350/1
Fig. 4 30/1

A SMALL PIECE OF STEEL, PENETRATING THROUGH THE CORNEA AND PUPIL INTO THE LENS, SUCCESSFULLY REMOVED BY THE EXTRACTION OF THE CATARACTOUS LENS FIVE MONTHS LATER.

By A. BARKAN, M.D., of San Francisco.

H. E. Horgan, a blacksmith, native of Massachusetts, thirty-three years, unmarried, always enjoyed good health and eyesight; had been living in Ophir District, Utah Territory, for some time past, following his occupation, when one day, working at a cold piece of steel, and striking the end of the steel (a pick such as is used for mining) with a hammer he felt that some sharp substance hit his left eye, causing for a moment a keen pain through the eyeball; he at once closed the other (right) eye, expecting as he said, "to see blood come from the injured eye," but seeing none, he immediately bathed it with cold water for a few minutes, the eye feeling perfectly well, was free from redness, and its vision apparently not in the least impaired. The patient continued working the remainder of the day—the accident happened about ten o'clock in the morning—and he slept tolerably well the following night.

The next morning the patient, who is a man of sober habits and good, clear intellect, examined his eye, and although he found its vision as good as ever, and that the eyball looked hardly at all red, and felt only "slightly sore," yet he was not easy in his mind, apprehending that a particle of steel of the pick might possibly have entered his eye; he therefore consulted a practising physician residing near the little mining place, who, after examining the eye, gave as his opinion, that there was nothing whatever in the eye, and prescribed some wash for the patient. That day—the one following the day of the accident—being a Sunday, the patient did not work, but rested his eyes; the next morning the eye felt perfectly well in every respect, and the slight soreness had entirely gone. The patient, therefore, started to work again, feeling no inconvenience whatever from the eye for a month afterwards—when one evening, on taking up a paper, he found that he could scarcely read the print with the injured eye. He immediately started for San Francisco, and about six weeks after

the injury had been received, he came to consult me, presenting the following interesting condition of *Status præsens.* The left eye looks quite natural on external inspection, is easily movable in every direction. The lids and conjunctiva perfectly normal—no swelling or injection being present. The cornea appears normal on the first glance, but on closer inspection a thin, whitish-gray opacity, situated about half a line below the centre of the cornea in the vertical meridian, about half the size of the head of a pin, smooth on its outer surface, and penetrating into the depth of the corneal tissue, becomes visible. The anterior chamber is of normal size and appearance, the aqueous humor perfectly clear, the iris promptly reacting upon light, showing no trace of a previous injury or inflammation, the pupil round in shape, and perfectly black in color; the intra-ocular tension appears normal, likewise the field of vision. S. $= \frac{15}{70}$; glasses do not improve the vision.

On examining the eye with oblique light, a cicatrix could be seen to penetrate the whole thickness of the cornea; nearly opposite it, on a straight line, directed from the cicatrix through the middle of the pupil, there was a wound in the anterior capsule of the lens about the size of a pin's head, and filled with a thin layer of a grayish-white mass; concentrating the light upon the lens-substance, a foreign body (piece of steel) was clearly recognizable in the upper and outer quadrant of the posterior cortical layers of the lens. The foreign body reflected the light strongly, was of a bright, yellowish color, seemed to be triangular in shape, with its point directed upward and backward, and had about the size of the end of a medium-sized gold-pen.

On ophthalmoscopical examination the corneal cicatrix, the capsular wound, and the foreign body were clearly seen to be situated in one line, which commencing near to the centre of the cornea, extended through the pupil and capsular wound to the rear part of the lens; traumatic cataract had already commenced to form—some of the posterior cortical layers being opaque, whilst the nucleus of the lens, the anterior cortical layers, and the anterior capsule, with exception of the wound, were as yet perfectly clear, admitting of the ophthalmoscopical examination of the vitreous body and background of the eye—which appeared to be normal.

It was evident that a minute and sharp pointed piece of steel had chipped off whilst the patient was working, had perforated the cornea with a great force, gone through the anterior chamber and pupil, opened the anterior capsule in the region of the anterior pole of the lens, and penetrated into the posterior

cortical layers, where it stuck—the corneal opacity and the capsular wound clearly showing the way which the foreign body had taken. Owing to the minuteness of the foreign body, and possibly also to the great force with which it struck the cornea, the cornea as well as the capsule of the lens closed again immediately after the foreign body entered, and probably no appreciable part of the aqueous humor escaped through the corneal wound. The foreign body came only to a very limited extent in contact with the fibres of the lens, as the development of the cataract proved to be very slow. The foreign body took its course through the middle of the pupil—without injuring the iris at all, causing a sharp pain only at the moment it perforated the cornea. Luckily for the patient the piece of steel had taken the most direct and safest route into the lens, without producing hemorrhage into the anterior chamber or wounding the iris; being retained in the lens, it caused neither pain nor inflammatory symptoms. Thus we can understand that the patient went on working and using his eye for four weeks, without knowing of the presence of a piece of steel within its lens. Since I had never seen such a case before, I asked the patient to call occasionally, that I might observe his eye, and having satisfied myself through repeated examination that the foreign body was firmly imbedded in the rear part of the lens, and that there was no danger of its changing place and falling into the vitreous body, taking also into consideration the total absence of inflammation, irritation or pain, I thought it best not to interfere for a time, but wait until the whole of the lens had become opaque.

From time to time I saw the patient, who showed little willingness to have an operation performed while the eye still enjoyed a certain amount of sight, the other eye being normal. I found during these examinations that the lens-fibres in front of the foreign body commenced to become opaque, the sight diminished, and in about four months from the time when I had first seen the patient—five months after the injury had been inflicted—he presented himself to me, the lens entirely opaque, the foreign body no longer visible, the eye perfectly free from irritation, the field of vision normal, the patient could see motions of the hand in front of the eye. He was now anxious to have an operation performed and the foreign body removed.

I settled upon Von Graefe's modified linear extraction, and removal of the lens within its capsule as the best method, and the one most likely to lead to successful removal of the foreign body from the eye. I performed the operation—kindly assisted by Drs. Hyams and Powers—the patient being thoroughly under the influence of chloroform. I made the section in the following way, the upper sclero-corneal junction forming an extensive conjunctival flap, excised a considerable portion of the iris, which had prolapsed into the wound, and I had just introduced Crichett's scoop into the sclerotical wound with the intention of passing it between corp. vitreum and lens, when the original wound in the anterior capsule reopened and greatly enlarged, and the opaque, soft lens matter gushed out with a good deal of vehemence, inclosing the foreign body, which was easily recognizable on account of its dark-gray color amidst the whitish lens substance. Neither hemorrhage into the anterior chamber, nor loss of vitreous took place, and the pupil was entirely black. I adapted the conjunctival flap and applied the bandage.

The recovery of the patient was as complete as it was quick. He had no pain at all, nor did any inflammatory reaction set in. Forty-eight hours after the operation the wound seemed entirely healed, the pupil was perfectly black, the patient counted fingers with ease at the distance of three feet. Two weeks after the operation I examined his sight and found $S = \frac{15}{20}$, with $+ \frac{1}{4}$; Jäg. No. 1 was read fluently with $+ \frac{1}{2}$ in 8″ distance. The little piece of steel, which was dark-gray and prismatic, weighed 0.006 grammes ($\frac{1}{10}$ grain). It was about two millimeters high and one millimeter broad.

The patient, highly satisfied with the result of the operation, returned to Utah Territory, to resume his occupation as a blacksmith in the mines.

A CASE OF EPITHELIAL CANCER OF THE CONJUNCTIVA.

By Dr. JAS. CHAPMAN, of Medina, N. Y., and Dr. H. KNAPP.*

(With Figs. 1–6, Tab. VIII.)

Nathan Bancroft, aged 70 years, in March, 1873, while chopping wood, received a blow from a chip or splinter of wood on the sclerotic, a line or two from the outer and upper margin of the cornea. This injury was followed by some inflammation, which subsided without treatment.

In November, 1873, I first examined the diseased eye. There appeared to be a thickening of the conjunctiva and subconjunctival tissue, these textures having a plicated appearance, the folds extending around the corneal margin, and encroaching a little upon its substance. Mr. Bancroft stated that he first discovered the growth in the month of September preceding, and that it was then situated on the sclerotic, about a line outside the outer and upper part of the circumference of the cornea. He wanted my opinion as to the nature of the disease, and as I told him I was in doubt in regard to its pathology, and my prescription was to let it alone for a time, he consulted another surgeon. In January, 1873, I saw him at a meeting of the Orleans County Medical Society, to which he was presented by his medical attendant. The disease had extended somewhat, and now half, or nearly half, of the cornea had become opaque. The medical gentlemen present, while suspecting cancer, agreed that they had never seen a case resembling it, and gave a very undecided opinion. During the months of February and March his eye became very painful. His sufferings were apparently increased by applications of sulphate of copper in substance to the growth, and he changed his medical attendant and treatment. Dr. T., who now took charge of him, confined himself to the administration of opiates and the instillation of sedative drops. The pain however increased, and became almost intolerable; and on the 24th of May, 1873, I was invited by Dr. T. to visit him in consultation. The cornea had become completely opaque to external appearance. He could, however, discern the light

* The history is by Dr. Ch., the description of the specimen by Dr. K.

from a window with the diseased eye. A tumor about eight or nine lines in length, and three or four in breadth, extended around the outer and upper quarter of the corneal circumference. This tumor was elevated at its centre, above the surface of the globe, about a line, or a line and a half, and its color was a rusty, yellowish white. The conjunctiva was deep red and thickened, especially at the outer canthus. The pain was most severe in the temporal region, but was also acute in the globe, head, face, and neck of the affected side. The patient complained of a feeling that there was a stick in the eye, and could scarcely be convinced that a splinter of wood had not lodged in the globe at the time of the injury. His strength and flesh were greatly reduced.

It was decided to remove the globe and the diseased conjunctiva reflexa, which, on the 26th day of May, 1873, I proceeded to do, in the presence of Drs. Thayer and Clark, of this place. Chloroform was administered, but with complete anæsthesia syncope came on, and the symptoms were so threatening that the anæsthetic was abandoned, restoratives applied, and he rallied so that the operation could be commenced. An incision was made through the outer canthus, then the conjunctiva was incised all round the globe, leaving only the conjunctival covering of the palpebral cartilages and the caruncle intact. The muscles were then drawn out with a strabismus hook, and divided; and, lastly, the optic-nerve was severed. The lachrymal gland was drawn out and removed, and any diseased tissue in the orbital cavity excised.

The whole operation being done with the scissors, except the first incision through the outer canthus. The relief from pain was immediate; and he declared he had the best night's sleep, the night after the operation, that he ever had in his life. The wound healed well. His appetite returned; and when I saw him this morning, May 13th, 1874, he told me that his health had steadily improved ever since his eye was removed, his weight being now one hundred and eighty pounds, while one year ago it was only one hundred and forty pounds. I also examined the cavity from which the eye was removed, and could see no signs of any return of the disease. He declares that he has no pain in the orbit whatever. The wound is cicatrized, the upper lid falling a little over the lower one.

Anatomical Examination of the Specimen.—A small part of the cornea only, about one-sixth of its area, was unaffected; the remainder was whitish-yellow (yellow, from the staining with Müller's fluid), and greatly swollen. The surrounding conjunctiva, to the width of five to eight millimeters, was converted into a moderately dense substance of an uneven, granular surface. A meridional

section showed the inner parts of the eye healthy, and the inner face of the cornea and sclerotic smooth and unchanged. The transverse section of the sclerotic (Tab. VIII., Fig. 1, *s*) and of the small unaffected part of the cornea (Fig. 1, *c*) mentioned above were likewise unaltered; but the remainder of the cornea (Fig. 1, *d*) was thickened in consequence of the infiltration of the pseudoplasm into its substance, its outer surface (Fig. 1, *o*) being smooth and moderately bright. That part of the growth (Fig. 1, *b*) which surrounded the cornea was in some places loosely (Fig. 1, *l*), in others firmly (Fig. 1, *i*) connected with the sclerotic, and here the extension of the growth into the corneal substance could be directly traced. Where the tumor was largest it had seven millimeters in thickness, as is seen in Fig. 2, which represents the tumor (*t*) in a somewhat oblique section through the sclero-corneal junction and its vicinity.

The pseudoplasm consisted in all its parts of well-marked epithelial cells, which lay closely together without any intervening substance. The cells were mostly large, with large nuclei and distinct nucleoli. The cell-body frequently presented a finely striped appearance, the stripes running in a radiating direction (Fig. 3, *a*). The contour of these cells appeared serrated (Fig. 3, *b*), thus the cell-wall had a furrowed surface like a ribbed-shell (Fig. 3, *c*). In many places the epithelial cells were arranged in cone-like figures, in others they were seen in a state of proliferation; a number of nuclei were embedded in dotted protoplasma, which had no definite boundary lines; or two and more cells, with single and double nuclei, lay in oblong or roundish spaces, with distinct, mostly serrated boundary lines. These figures bore some resemblance to capsulated cartilage cells. In its structure, therefore, the growth had no distinguishing feature from the usual epithelial cancer. The serrated condition of the epithelial cells, which was so plain in the majority of preparations when examined with higher magnifying powers (Hartnack, No. 9 dry, or 12 immersion), may, perhaps, not prove a rare condition if closer attention be paid to the outline of the cells. See: Waldeyer, Virch. Arch., vol. 41 p. 470, etc.

The *origin* of the growth was, as far as we could judge, in the epithelial layer of the conjunctiva. Here a dense accumulation of cells indicated the hyperplasia of the original elementary parts.

The *propagation* of the pseudoplasm was by uninterrupted extension of epithelioid cells into the neighboring tissue. The subconjunctival cellular tissue had in many places preserved its fibrous character, but rows of epithelioid cells stretched from the growth between the fibre-bundles, evidence of the propagation of the pseudoplasm into the vicinity by unbroken strings of cells. The same mode of propagation could with the greatest distinction be demonstrated *in the cornea*. At the corneo-scleral juncture the cells, penetrating into the corneal substance, followed the tracks of the corneal canals, which they expanded and filled in a way similar to what we see in suppurative keratitis (Fig. 4, *a*.) The infiltration of the foreign elements could be readily recognized by their color, which was yellow, whereas the normal elementary parts of the cornea were white. The anterior epithelium (Fig. 4, *c*), Bowman's lamella (*b*), and the regular arrangement of the corneal corpuscles were preserved. A greater magnifying power showed that the cells (Fig. 5), which infiltrated the cornea, were epithelial cells. They were seen in small (Fig. 5, *b*) and large (Fig. 5, *c*,) clusters, and in long rows (Fig. 5, *a*). In many places (Fig. 5, *d*) the corneal corpuscles were dilated and contained two or more epithelioid cells, recognizable by their size and color. A greater magnifying power (Hartnack, immersion No. 12) showed even in these small clusters (Fig. 6) the enclosed cells with all the characteristic qualities of epithelial formations. Some of these cells (Fig. 6, *a*) exhibited the stripes in the cell-body as plainly as was noticed in the episcleral tumor. The corneal tissue, apart from this infiltration, was healthy. The inner structures of the eye had been removed from the specimen, but Dr. Chapman stated that they presented nothing unusual.

The case under consideration presents some features worthy of note :

1. *Its origin from an injury*.—Though a number of instances are on record in which tumors of different description, cancers included, have been the result of injuries, yet the authenticity of the casual connection between the injury and the growth has been doubted. Those who believe that cancer is a primarily constitutional disease, cannot admit that a trauma may be the cause of a cancerous growth, and they assume in such cases that the patient, when receiving the injury, suffered already from can-

cerous diathesis. *The successful operation of malignant intra-ocular growths (sarcomatous and encephaloid) by early enucleation of the eyeball, of which a limited number of well-authenticated cases is now on the records of science, is, I should think, convincing proof that in the initial stage a malignant growth may be a local affection.* If irritations of different kinds may produce in a certain locality cells with infectious properties that will sooner or later manifest themselves at some distance from the original focus and poison the whole organism, why should not an injury as well as cold or other causes occasion such an irritation as is necessary to produce cellular elements with infectious properties? I am under the impression that these views are supported by the authority of Virchow. In the case under consideration the injury had struck the conjunctiva scleroticæ, a place which is only rarely the seat of primary cancer. It was followed by inflammatory reaction, which soon subsided. Six months later the patient had first noticed that a growth had developed at the place of the former injury, and from that time the increase of the tumor had been steady.

2. *It was an instance of primary epithelial cancer of the conjunctiva, which is a rare disease.* The history states that the growth, when first noticed, was situated on the sclerotic, about a line from the corneal margin. This is its ordinary seat. The disease has in its first stage the appearance of a broad, flat phlyctenula, for which, in some instances, it has been mistaken. The literature on this subject, with abstracts of the cases, is to be found in A. CLASSEN'S paper: Ueber ein Cancroid der Cornea u. Sclera. Virch. Arch. L., p. 56; and in F. HORNER'S paper: Tumoren in der Umgebung des Auges. Klin. Monatsbl. f. Augenh., 1871, p. 1, etc.

3. *The extension of the neoplasm by uninterrupted rows of epithelial cells* could, in the case under observation, unusually well be demonstrated in the cornea. In a case by H. ALTHOF (Graefe's Archiv, X.), and another by B. SOCIN (Sarcoma conjunctivæ. Virch. Arch. LII. p. 550), a similar condition is described, namely, club-like, polypoid excrescences, extended, like the roots of a tree, between the lamellæ of the corneal tissue. No structure in the human body is so well adapted as the cornea to study the intrusion of foreign elements, since the elementary

parts of the normal condition display a well-known picture of an exquisitely regular arrangement. The foreign elements in the case before us were found in long, unbroken strings of cells, emanating from the episcleral growth, and in smaller or larger clusters, which, on their part, followed likewise the course of the corneal (lymphatic) canals. It seems most plausible that young cells travelled through these channels, and, multiplying, first filled and expanded the lacunæ (corpuscles) of the cornea, and after that their intermediate offsets. The hypothesis appears forced, that disseminate, isolated clusters, primarily formed in the neighborhood of the original growth, and by subsequent coalescence, produced the long and uninterrupted rows of cells.

No blood-vessels were recognizable in the infiltrated portion of the cornea. I mention this particularly, since Classen (l. c.) found blood-vessels in the tissue of the cornea and lymphoid cells in their vicinity. He thinks that these lymphoid cells are white blood-corpuscles, transuded through the walls of the vessels, and are converted into epithelioid cells, the elementary parts of cancer.

4. *The young elementary parts in the corneal portion of the tumor had the characteristic of the original pseudoplasm.* They were not indifferent lymphoid cells which we frequently find in growing sarcomata and alveolar cancers, but true epithelial cells. In the cornea of this specimen, therefore, we found no conversion of connective-tissue elements into cancer, but the immediate continuation of the proliferating epithelial cells of the conjunctiva. In some places of the conjunctival tumor, small, round, lymphoid cells were distinct and abundant enough.

TWO CASES OF RETINAL GLIOMA.

By H. KNAPP, M.D.

(With Figs. 7 and 8, Tab. VIII.)

Dr. E. Williams, of Cincinnati, to whom I am indebted for many a valuable pathological specimen, recently sent me again the histories of two cases of glioma retinæ, together with the enucleated eyeballs, the description of which shows some features worthy of being placed on record.

Case I.—— Bischof, æt. 12 years, slender in form and sallow of complexion, but in good health, was brought to me Feb. 21, 1874. One week before a playmate at school noticed a peculiar reflection from her left eye, and on trial it was found blind. She had had no inconvenience from it, nor knowledge of its condition till then. Nothing in the history of the patient throws any light upon the occurrence, or fixes its date. The associated movements of the irides were intact, but exclusion of the good eye showed a large and fixed pupil. The fundus presented the characteristic metallic lustre, rather red, like the color of copper. Numerous vessels could he seen traversing the surface of the fundus, but not having the regular distribution of the retinal vessels. The eye was absolutely free from all pain, redness, or other external alteration, and the tension normal.

The eye was enucleated by my partner, Dr. Ayres, in the usual way, great pains being taken to divide the optic nerve far back. Recovery was prompt, and there has never been the slightest trouble or suspicion of reproduction up to the present time (Aug. 10, 1874). We advised against the use of an artificial eye, not wishing to increase the risk of reproduction by any local irritation. I shall keep the patient under observation, and report any thing that may take place hereafter.

E. Williams.

Anatomical Examination of the Eyeball.—The globe, hardened in Müller's fluid, had its natural size, and presented no external anomaly. A meridional section (see Fig. 7, Tab. viii.) showed the retina totally detached and corrugated, passing like a cord

from the optic nerve to the posterior surface of the lens capsule, where it expanded laterally, and was attached to the posterior edge of the ciliary body. The parietal (external) surface of the corrugated retina, especially on its anterior part, was beset with a number of roundish elevations. The section-surface of the retinal cord was partially granular, partially striated, white, with some black patches. The front part, which extended transversely through the globe, could be readily detached from the ciliary processes and crystalline body. The tissue of the retina was replaced by a dense accumulation of small round cells, embedded in a granular matrix. The black patches consisted of the same cells, the majority of which, however, were pigmented. In addition to them, irregular pigment cells and pigment granules were seen in these patches. The nodular elevations on the external surface showed the ordinary glioma structure. A great part of their cellular elements originated in the pars ciliaris retinæ, and may be considered as hyperplastic formations of the granules normally interspersed between the radiating fibres of that membrane.

Two conditions were unusual in this case: 1st, *the age of the patient* (12 years) is more advanced than we commonly find in glioma of the retina; 2d, the greatest development of the pseudoplasm in the *anterior and ciliary parts* of the retina is also against the rule. The pigment patches, too, are not frequently seen in so great an extent as in this specimen. The pigment, in all probability, was the result of hemorrhage.

The *prognosis* in this case appears favorable, as the pseudoplasm did not seem to possess a great tendency to proliferate, and was limited to the retina. The comparatively advanced age of the patient may also be considered a favorable condition concerning a permanent recovery.

Case II.—B. S., a boy, æt. 4½ years, of reddish complexion, well developed and bright in intellect, came under Dr. E. Williams' care on March 6th, 1874. About two years previously the parents noticed a "white spot in the pupil" of one eye, which gradually enlarged, but entirely without pain. The physician called it cataract, and sight had been abolished for a year. About five weeks previously exophthalmus was first noticed, which increased rapidly to such a degree that the globe was

completely luxated, and the lids contracted behind it. The eye was tender, and the boy felt a good deal of pain in his bowels. The cornea, as far as it could be distinguished from the swollen and very vascular globe, was of a dark reddish-brown color, looking like a dry coagulum of blood. The diagnosis was glioma, extending along the optic nerve. As an only hope, Dr. W. advised and performed an immediate enucleation. The conjunctiva, very much thickened, was cut a little in front of the equator, easily detached by the scissors, and the eye enucleated in the usual way. The optic nerve was felt very much enlarged, and the pressure of the finger backward caused the rupture of the cornea and the escape of some brain-like substance. To avoid the further collapse of the eye, the nerve was divided a short distance behind the globe. The stump of the nerve was then isolated and cut off close to the optic foramen, where it was still large and lardaceous. The recovery from the operation was rapid; and three days afterwards the boy was taken to his home in the country, greatly relieved. The prognosis, of course, was hopeless: rapid and fatal reproduction being anticipated in a few weeks or months at most. I could find no evidence of tumors elsewhere, although the abdominal pain was suspicious.

From letters afterwards received from Drs. Weaver and Kindell, the following is a condensed report of the progress of the case. The boy was lively and doing well till April 1, when he grew peevish and fretful, complaining of a pain in the head, and vomited frequently. He had dysuria and persistent constipation. After these symptoms had lasted for two weeks, they noticed a growth in the orbit, which increased rapidly, and soon projected between the lids. By the first of June the tumor was as large as a hen's egg, of a dark-red color, with blood constantly oozing out, when not controlled by astringents. He died June 15. No post mortem was allowed. The body was very much emaciated. On palpation a tumor could be felt in the abdominal cavity, the size of a man's wrist, deep-seated and extending from the transverse colon to the iliac fossa. Three weeks before death he became blind in the right eye, the disease having then, no doubt, invaded the optic chiasm. The orbital tumor, removed after death, is round, lobulated, and about two inches in diameter in all directions. Microscopically examined by Dr. A. D. Bender, of this city, it was pronounced "glioma-sarcoma."

Anatomical Examination.—The eyeball, of which the figure 8, Tab. viii., gives an illustration in natural size, had the shape of a goblet, and presented a number of roundish protrusions in the ciliary region, where the slcerotic was thinned, but not perforated. The cornea had sloughed away, and through the aperture protruded the soft, brain-like substance with which the whole globe was filled. On the posterior part of the sclerotic some soft tumors were seen, which partially surrounded the thickened optic nerve, but were in no connection with it. On careful dissection a place was found in which, by way of a short pedicle, the episcleral tumor communicated with the intra-ocular growth. On this place the sclerotic was thinned and macerated, yielding readily to a probe, but offering resistance enough to show that many fibres were preserved. The growth here made its exit from the globe by forcing its way through the interlamellar spaces of the sclerotic. The pseudoplasm had the structure of glioma in all its parts. The thickened optic nerve was densely filled with small cells, the nervous fibres being mostly replaced by the pseudoplasm.

This eyeball presented a marked specimen of the third stage of glioma in which the growth, enlarging and perforating the globe, extends into the orbit and the cranial cavity. Besides the usual place of perforation, there was one in the posterior part of the sclerotic, showing, even microscopically, the direct connection between the intra-ocular and orbital portions of the pseudoplasm. The ciliary staphylomata also were not without interest, demonstrating that not only an excess of fluid contents, as in hydrophthalmus, but a neoplasm when filling the globe, overcomes the resistance of the sclero-corneal capsule by preference in the ciliary region.

A CASE OF NEURO-RETINITIS RESULTING FROM A GUMMY TUMOR OF THE DURA MATER.

By H. KNAPP, M.D.

RETINITIS in syphilitic persons has mostly no peculiar features distinguishing it from retinitis produced by other causes than lues. Two conditions, however, may be mentioned as being, in the great majority of cases, of syphilitic origin: 1st, irregular white stripes radiating from the papilla optica in the course of the blood-vessels being sometimes flat, sometimes considerably raised over the level of the retina; 2d, small, roundish, white patches, of fatty appearance, dispersed in some cases over the whole retina, in others limited to certain places in which they are so densely crowded as to resemble a piece of mosaic work. In the region of the yellow spot and its surroundings I have seen striking pictures of this second condition, which is totally different from the well-known radiating figures so frequently witnessed in this region in cases of Bright's disease and neuro-retinitis, the consequence of morbid processes in the orbital or cranial cavities.

In the following case, which came under my care in Charity Hospital two weeks before the fatal issue, the retina showed the ordinary picture of neuro-retinitis passing into atrophy of the optic nerves. The arteries were small and straight, the veins thickened and somewhat tortuous, the optic discs whiter than usual, their choroidal borders irregular. No other abnormity was found in the fundus oculi, though the examination was made in remembrance of the distinct history of syphilis obtained from the patient. Her death occurred unexpectedly, and I am sorry that I was not informed of it in time to witness the autopsy and prevent the eyes from being buried. The brain, however, which was preserved for me intact, showed so conspicuous a lesion that its examination rendered the case both interesting and instructive. For the clinical history of the disease I am indebted to Dr A. M.

PIERCE, at the time resident physician to Charity Hospital, N. Y.

Eliza Ring, aged 32 years, native of Ireland, married, occupation domestic, has been in the hospital several times for treatment. Eleven years ago she had a sore on her vulva, which was followed in due course of time by the secondary and tertiary lesions of syphilis. Two and a half years ago a small tumor appeared on the centre of the frontal bone. It had reached the size of a hen's egg, and was hard and immovable when she came into the hospital, May 30th, 1873. It disappeared under the influence of iodide of potassium.

Nov. 5th.—Patient again admitted to the hospital. During the last four or five months she has had a *constant headache.* While in the hospital she had several *epileptiform convulsions* and notable *exophthalmus* with impairment of sight in both eyes. Under treatment she got better and was discharged.

Jan. 28th, 1874.—Patient again enters the hospital. The exophthalmus has nearly disappeared, but she still complains of dimness of vision and pain in her head, which is generally constant and worse at night.

The examination with the ophthalmoscope revealed the ordinary features of neuro-retinitis, with commencing atrophy of the optic nerve in both eyes. Two hours before her death, which occurred February 18th, she had an epileptiform convulsion, which was followed by coma, and in this condition she remained until death.

Sixteen hours after death the autopsy was made by Dr. Drake, who in substance entered the following notes into the post-mortem book :

Body medium size, well developed, and well nourished. Œdema of the legs.

Head. At the anterior portion of the anterior lobe of the left hemisphere was a large gummy tumor (see subsequent figure) of the dura mater extending into the brain substance. The brain substance (*m*) surrounding the tumor was softened, as far backward as the posterior lobe. At the most anterior portion it was almost fluid. The left ventricle was dilated, filled with fluid, and its floor softened. The veins on the left side were greatly distended.

Thorax. Heart hypertrophied and dilated. The aorta was atheromatous.

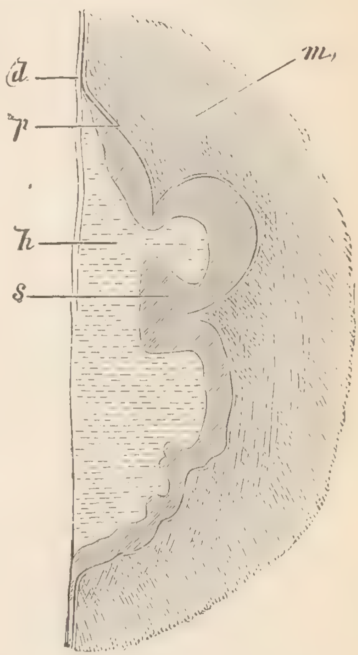
Lungs. Both lungs greatly congested and œdematous.

Abdomen. Liver enlarged, congested and slightly waxy, exhibiting the characteristic coloration with the iodine test.

Spleen soft.

Kidneys in the first stage of acute parenchymatous inflammation.

Minute examination of the Brain.—The right hemisphere, the posterior lobe of the left, the cerebellum and the medulla oblongata showed no abnormity, the middle lobe of the left hemisphere was softened and white, showing no other alteration than the simple decay of the brain-substance by maceration, most advanced in the vicinity of the pseudoplasm. The meninges were normal, except on the front part of the left anterior lobe where the parietal surface of the dura mater was rough and reddish in a space two inches in the antero-posterior diameter, and one inch and a half in the transverse. In the same place the dura was inseparably united to a tumor (see accompanying figure) which was nodular and penetrated into the brain-substance. On careful dissection the pia mater (*p* in the figure) was found unchanged; it lined the surface of the tumor, and could be detached from it. At the periphery it was united to the dura, but lay loose over the nodules of the pseudoplasm, and dipped into the depressions between its larger nodes. On incision the tumor was found in intimate connection with the dura (*d*). Its larger portion (*h*), which sprang from the dura, was yellowish-white, opaque and hardish like fibro-cartilage, whereas the peripheric portion (*s*) was transparent, hyaline, and softer than the central portion which it lined in a nearly uniform thickness of three millimeters.



The *microscope* revealed in the outer, gum-like layer, an accumulation of small cells embedded in a moderate quantity of homogeneous basis-substance. The majority of the cells were round, and had large nuclei surrounded by a thin, but conspicuous layer of protoplasm.

Some of the cells had one or two short offsets, others were elongated. There was in this layer a moderate amount of fat granules between the cells and within them, as well as a good supply of blood-vessels. The yellowish-white, hard portion consisted of the same kind of cells that were found in the softer layer, but, in addition, of a considerable quantity of spindle-shaped cells, which in some places lay densely together, in others were sparsely scattered through the round cells. Here and there was a net work of anastomosing stellate cells. The matrix of this harder portion of the tumor was likewise homogeneous or finely granular, but less abundant than in the soft layer. The cells and matrix of the hard portion were distinguished by a large quantity of granular fat. In some places the cells had disappeared to such a degree under the fatty degeneration as to make the structure of the tumor appear to be a granular, fatty, amorphous substance. There were many blood-vessels in this portion also.

The outer layers of the dura mater were unchanged, the inner were separated by rows of small cells which passed over into the pseudoplasm without the interposition of any other tissue-elements.

This examination showed clearly that the neoplasm was a gummy tumor originating in the visceral surface of the dura mater. It answers in every respect to the classical description R. Virchow gives of it in his work on morbid growths, vol. II., p. 449, etc. It is an uncommonly large specimen of its kind. The softening of the adjacent parts of the brain (*m* in the figure) is a usual concomitant symptom of gummy tumors of the meninges.

Ophthalmologically this case is of importance, adding another example to those in which a tumor, remote from the cavernous sinuses, produced the well-known picture of neuro-retinitis in both eyes. The substance, meninges, and nerves of the base of the brain, showed no abnormity. Though the left ventricle was distended and the veins of the left side were greatly dilated, the neuro-retinitis was of the same kind and degree on both sides. This is not always the case, as we frequently find that eye most affected which corresponds to the diseased hemisphere. The eyes having not been preserved, the case throws no light on the question as to whether neuro-retinitis owes its origin to increased

intracranial pressure, or to the propagation of fluid exudation through the subvaginal space of the optic nerve. The prominent clinical symptom was the constant headache. Upon it, the neuro-retinitis, the epileptiform seizures, and the pronounced history of tertiary syphilis, the diagnosis of gummy tumor in the cranium was based, a diagnosis which had been made prior to the patient's death.

OPHTHALMOLOGICAL REVIEW.

By Emil Gruening.

1. Dr. Fr. Hosch. Das Epithel der vordern Linsenkapsel. (On the epithelium of the anterior capsule of the lens). *Graefe's Arch. f. Ophthal.*, xx. 1, p. 83, etc.

2. Dr. M. Reich. Zur Histologie der Hechtretina. (Contribution to the histology of the retina of the pike). *Graefe's Arch. f. Ophthal.*, xx. 1, p. 1, etc.

3. Prof. Wm. Turner. Examples of variations in the arrangement of the nerves of the human body. Fourth cranial nerve. *Journal of Anatomy and Physiology*, by G. M. Humphreys and Wm. Turner. Second Series, N. xiv., p. 296. May 1874.

4. Waldemar Krenchel. Ueber die Wirkung des Muscarins auf Accommodation und Pupille. (On the action of muscarine upon the accommodation and pupil). *Graefe's Arch. f. Ophthal.*, xx. 1, p. 135, etc.

5. Waldemar Krenchel. Untersuchungen über die Folgen der Sehnervendurchschneidung beim Frosch. (Experimental investigations as to the results of section of the optic nerve in frogs. *Graefe's Arch. f. Ophthal.*, xx. 1, p. 127, etc.

6. Th. Brittin Archer. Versuche über Tätowirung der Hornhaut. (Experiments on tattooing of the cornea). *Graefe's Arch. f. Ophthal.*, xx. 1, p. 225, etc.

7. H. Charlton Bastian. Clinical lectures on the common forms of paralysis from brain disease. *The London Lancet*, Oct., 1874, p. 481. (Lecture iv., p. 1. The sense of sight).

8. R. Förster. Zur klinischen Kenntniss der Chorioiditis syphilitica. (Contributions to the clinical knowledge of syphilitic choroiditis. *Graefe's Arch. f. Ophthal.*, xx. 1, p. 33, etc.

9. W. Zehender. Embolie oder Hæmorrhagie der Art. centralis retinæ innerhalb des Sehnerven? (Embolism or Hæmorrhage of the central retinal artery within the optic nerve?). *Klin. Monatsbl. f. Augenh.*, xii., p. 310, 1874.

10. André. Luxation sous-conjonctivale du cristallin sans traumatisme. (Spontaneous dislocation of the lens under the conjunctiva). *Annales d'oculistique*, LXXII., Sept., Oct., 1874, p. 111.

11. ALBERT MOOREN. Ophthalmologische Mittheilungen aus dem Jahre 1873. (Ophthalmological contributions, 1873). Berlin, 1874, p. 20.

1. Carcinoma of lachrymal gland. 2. Fibroma of lachrymal gland.

12. EDUARD HERRMANN GARVENS. Ueber die Iridotomie. (On Iridotomy), Munich, 1874.

I. In a number of human and animal lenses Hosch examined the intracapsular epithetial cells which had hitherto been described as either regularly or irregularly polygonal, and sharply defined in outline. The method employed consisted in excision of the anterior capsule, and two or three days, maceration in iodized serum. The specimens were then either teased or shaken in serum. The epithetial cells contained severally a large nucleus, and were provided with either simply tapering or bifurcated processes. The cells obtained by agitating the capsule in serum exhibited tender processes tapering to fine points and, in some instances, branching in various directions. In some preparations the cells were not entirely insulated but cohered in small groups. Here it could be distinctly seen that the processes of some cells passed behind the neighboring cells under the cover of which they disappeared. Viewed in toto the epithelium invariably presented the aspect of a single layer of polygonal cells containing severally a large round or oblong nucleus. Isolated the cells showed various forms according to the development of their processes.

II. On examining the retina of the pike, Reich made several interesting observations regarding the structure of the internal granular, intergranular, and bacillar layers.

The layer of internal granules consists : 1st, of round or oval cells, measuring from 0.006 to 0.008 mm. in diameter, and having a comparatively large nucleus and but little protoplasma. These cells, many of which present the aspect of the smaller cells of the ganglion layer, are provided with two processes. One of these is directed to the periphery, the other to the centre ; 2d, of large cells, measuring from 0.02 to 0.028 mm. in length, from 0.006 to 0.01 mm. in width, and enclosing a nucleus corresponding in size to that of the smaller cells mentioned sub 1. The larger cells, the shape of which is more or less irregularly triangular or quadrangular, exhibit likewise two processes. The peripheral processes are thicker than those of the smaller cells, and can in many instances be traced through the intergranular layer.

The latter is composed of several cellular strata, ordinarily three, at times four, and of one layer of interlacing bands in apposition with the internal granular layer.

In carefully teased preparations of the retina, previously hardened in perosmic acid, the layer of rods and cones shows the following picture :

Between the long rods, which in many instances are curved, but show no sign of resolution in laminæ, we see many very thin, bristle-like processes, deeply stained by perosmic acid. In a state of good preservation these processes correspond in length to the rods. R. maintains that these formations represent the external segments of the cones. Schultze and Krause describe the external segments of the cones of the pike as being considerably shorter than the external segments of the rods.

III. In the right orbit of an adult male a well marked branch was observed to arise from the fourth cranial nerve close to the superior oblique muscle. This branch ran forward parallel to that muscle as far as the upper border of the orbit, where it branched, the branches entering the orbicularis palpebrarum. This muscle was then dissected, and the finer subdivisions of the nerve were traced into the fasciculi of the muscle, at the inner part of the upper eyelid. In the opposite orbit the fourth nerve was normal.

In an adult female subject, Mr. H. S. Stone, dissected in the left orbit, a small branch arising from the fourth nerve immediately after it had passed through the sphenoidal fissure. It ran forwards, close to the inner side of the superior oblique, and about three-fourths of an inch from the upper orbital border formed a plexus with the infra-trochlear branch of the nasal ; from this plexus branches arose, those most in line with the branch of the fourth passed to the orbicularis palpebrarum external to the trochlea and immediately beneath the orbital arch ; those most in line with the infra-trochlear were traced to the mucous membrane of the upper eyelid. The nerve on the opposite side was normal.

Murray, as quoted by Henle, had also seen one case in which a branch of the fourth communicated will the infra-trochlear. In another adult female, Mr. Stone, traced in the left orbit a branch for the fourth nerve, which ran forward parallel to the outer side of the superior oblique, and near the upper orbital border broke up into filaments which entered the periosteum of the anterior part of the roof of the orbit immediately to the outer side of the trochlea.

IV. K. confirms in the main the discovery made by Schmiedeberg and Koppe as to the action of muscarine upon the pupil and accommodation. Muscarine causes myosis, and tetanizes the ciliary muscle. The latter action becomes manifest as a spasm of accommodation, characterized by rapidly increasing myopia, lasting from one hour to two hours and a half.

The action of muscarine differs from that of physostigmine in two points :

1. Physostigmine contracts the pupil very readily, but affects the

accommodation slowly; muscarine, on the contrary, increases the refraction of the eye speedily, but proves slow in its action upon the pupil.

2. Physostigmine causes increased functional activity, and, if the dose be large, actual spasm of the ciliary muscle; muscarine, inversely, causes in the first place a spasm, which is followed by increased functional activity.

V. Krenchel divided the optic nerves of twenty-seven frogs according to the method described by Berlin. The results obtained were fully in unison with those of Berlin, viz: Stasis in the retinal vessels, white discoloration, and in some cases detachment of the retina, and, if the frogs survived the operation a sufficiently long time, the ophthalmoscopic picture of a dark fundus sowed with white specks.

Acting upon the supposition that these changes might be due rather to the inevitable division of the retinal and ciliary blood-vessels, than to the cutting of the nerve, Krenchel devised a method of intracranial section of the nerve without implication of the vessels. In frogs operated upon by this method the eyes showed neither ophthalmoscopic nor microscopic changes. The pupils retained permanently a certain degree of mobility.

VI. A. made a series of experiments upon rabbits for the purpose of examining various coloring substances as regards their applicability in tattooing leucomatous corneæ. He employed India ink, Prussian blue, ultramarine, indigo, sienna, and gamboge. Of these substances India ink, ultramarine, and sienna caused but little inflammation, which soon subsided, leaving a perfectly clear cornea, with a decidedly black, blue, or brown speck at the point of tattooing. Indigo and Prussian blue produced only slight reaction, but disappeared partially, tinting the cornea very faintly. Gamboge occasioned intense inflammation, succeeded by mortification of the parts tattooed. From these experiments A. draws the conclusions, that for the purpose in question India ink, ultramarine, and sienna are very useful, that Prussian blue and indigo are less useful, and that gamboge must be totally discarded.

By a second series of experiments upon frogs the author endeavored to determine in which of the elements of the corneal tissue the particles of pigment (ultramarine) became fixed. In a frog examined twenty-five days after the operation the corneal epithelium was entirely restored and free from pigment. In the fibrillary substance, at the points of tattooing, particles of coloring matter were collected in small but well-defined spaces, the dimensions of which exceeded, in many instances, those of the corneal corpuscles. The total amount of pigment introduced was decidedly diminished. A few wandering cells were scattered in the fibrillary tissue;

they contained no pigment. By a careful examination of the blood, A. found several corpuscles containing blue pigment.

VII. The sense of sight is much more frequently affected in intracranial disease than the sense of hearing, this being due in the main to the much greater length of the optic tract and nerve within the skull, and to their varied blood supply. It happens not unfrequently that one of the optic nerves in a portion of its course from the retina to the opposite side of the corpora quadrigemina becomes compressed or otherwise affected by some pathological lesion which at the same time suffices to determine a hemiplegic condition. This is the case, for instance, when with thrombosis existing in the carotid and middle cerebral arteries on one side a branch of the thrombus also extends into the ophthalmic artery. Here the eye is affected on the side opposite to that of the paralysis of the limbs, and the occurrence of this event more or less simultaneously with the onset of hemiplegia has therefore in some cases an important diagnostic significance; just as the simultaneous onset of loss of sight on the same side as paralysis of the limbs points to an affection of the optic nerve after its decussation, or of the corpora quadrigemina—the latter being a combination which exists not unfrequently where thrombosis of one of the posterior cerebral arteries exists as a cause of hemiplegia. Pressure upon the optic tract itself may occur from lesions of various kinds, and, among others, from hæmorrhages into the lower part of the sphenoidal lobe, or into the substance of the crus cerebri. But in all these cases where there is an interference with the optic centre, or of the optic tract of one side behind the chiasma, partial or complete blindness occurs on the same side as the paralysis of the limbs, and the sight of the other eye remains intact. Thus the data furnished by disease point to the conclusion that the visual impressions from the whole of one eye, and from that only, pass to the corpora quadrigemina of the opposite side of the body—that is to say, to the conclusion that the decussation of the optic fibres at the chiasma is complete.

Where lesions implicate the anterior quadrigeminal body on each side, the blindness is double and complete. An instance of this kind occurred in the hospital about two years ago, in a man who was under the care of Dr. Reynolds. A long illness, in which polyuria was one of the most prominent symptons, was brought to a close by blindness and some degree of stupor for about 14 days; and after the death of this patient a patch of softening was found almost limited to the anterior part of quadrigeminal bodies. Other cases of this kind are on record. But just as we may have a temporary paralysis of the limbs, without obvious cerebral change, following certain epileptic attacks, so a temporary blind

ness not unfrequently occurs after injuries to the brain, with or without epileptic phenomena. On these occasions the optic centres appear to be acted upon in an "indirect" manner, by lesions occurring in other and perhaps distant parts of the brain. Blindness on both sides may thus be produced for several days, or even for one, two, or more weeks; and such an event is more apt to occur where the hemiplegia has been initiated by an epileptiform attack, or by a series of them, than when such initial phenomena have been absent. Hæmorrhage and softening have of themselves little tendency to set up optic neuritis. They thus differ very notably from tumors within the cranium.

VIII. Förster considers that form of disease as syphilitic choroiditis, which Jacobson, in 1859, described as "Syphilitic Retinitis," and which since that time has been regarded as such by every observer. F. adduces he following facts as arguing in favor of his view.

1. The disease is frequently associated with iritis. If we consider the isolation of the vascular supply of the retina, we can *àpriori* not assume the probability of the transition of inflammatory processes from the retina to the iris and *vice versa.* Such transition has in fact not been observed in cases where the disease was indisputably located in the retina, while on the other side inflammations of the choroid are frequently combined with iritis. The choroid participates in inflammations of the iris much more frequently than is generally supposed. In unilateral iritis we very often find the optic papilla of the affected much redder than that of the sound eye. This increased redness must be considered as a manifestation of capillary congestion of the choroid.

2. The symptom of hemeralopia, so well marked in the affection under consideration, does not occur in diseases of the optic nerve and the anterior layers of the retina, but is invariably connected with inflammations of the choroid.

3. Cloudiness of the vitreous, a constant concomitant of the so-called "Syphilitic Retinitis," is found almost always in *choroidal* but exceedingly rarely in *retinal* inflammations.

4. Limitation of the range of accommodation, invariably a manifestation of "Syphilitic Retinitis," is most commonly associated with choroidal and not with retinal affections.

5. The changes occurring in the retina and the choroid, after a protracted and unfavorable course of the disease, most emphatically point to the fact that the choroid and not the retina had been primarily affected.

IX. The positiveness of the diagnosis of embolism of the central retinal artery has been recently called in question by Loring* and

*Remarks on Embolism, Amer. Jour. Medical Sciences, No. cxxxxvi., April, 1874.

Magnus.* Zehender observed a case of sudden blindness evidently not due to embolism of the central retinal artery, though, according to custom, this diagnosis ought to have been made.

The right eye of a young farmer had suddenly become blind without an assignable cause. An examination was made four days after this occurrence.

The left eye was normal, its sight perfect. With the right eye the patient could perceive with difficulty the flame of a candle in a dark room, at the distance of two to two and a half feet. The ophthalmoscope showed the well-known red patch at the macula lutea and a whitish infiltration of the surrounding retinal district. In this infiltrated portion the retinal vessels were strikingly distinct, exhibited a somewhat tortuous course, and were at several points covered by the opacity. At their point of exit from the papilla the arteries were pale and apparently bloodless, while the principal venous branches were well filled and showed a very distinct venous pulsation. This phenomenon argued strongly against the possibility of embolism of the central retinal artery.

X. It has been stated that subconjunctival dislocation of the lens is always due to an accident, most commonly to a blow upon the eye. The following remarkable case, observed by Dr André, seems to demonstrate that such dislocation may take place without a traumatic cause :

A woman, sixty seven years of age, had lost the sight of the right eye fifteen years since. The sight of the left eye had been reduced to quantitative perception of light during the last three years. On examination the eyes presented the following condition :

Right eye.—Anterior chamber deep, iris tremulous, pupil drawn up and of battledoor shape. On lifting the upper lid the whole lens was found to be lodged under the conjunctiva, its lower border being at a distance of two millimetres from the upper corneal margin. The opening through which the lens had escaped was closed. Upon inquiry the patient emphatically stated that she had never received a blow upon the eye.

The eyeball was soft. Perception of light extinct. The ophthalmoscope showed a very deep glaucomatous excavation of the optic papilla.

Left eye.—The pupil was irregular and drawn up, the iris forming a considerable prolapse through a gap in the sclero-corneal margin. The upper segment of the opaque lens was tightly wedged in this gap, and covered by the prolapsed iris.

The author is of opinion that the glaucomatous process, which caused the excavation of the optic papilla, also occasioned the sclerotic rupture through which the lens had escaped.

* Die Sehnervenblutungen, Leipzig, 1874.

XI. Mooren observed a case of carcinomatous degeneration of both lachrymal glands in a woman aged 50 years. The affection had developed with great rapidity, simultaneously on both sides, without giving rise to any sensation ofpain. The patient suffered from a very high degree of ptosis, and was obliged to throw her head back in order to see. The neoplasms formed large lobulated masses along the upper orbital margins. Both tumors were removed. The wounds healed rapidly. An inconsiderable degree of ptosis remained, giving to the patient a sleepy expression of countenance. Two months later the tumors had recurred on both sides, and were again removed. During the process of healing the cervical glands became infiltrated with the carcinomatous deposits. A few weeks subsequently the patient died of *carcinoma of the liver.*

In a case of fibroma of the right lachrymal gland the result of the operation was more satisfactory. The patient had been under observation for several years, during which time the development of the tumor had been slow, but steadily progressive. At the time of the operation (June, 1873), the right eyeball squinted considerably inward, and stood three-fourths of an inch lower than its fellow. Mobility outward was completely abolished ; the lid could not be lifted, notwithstanding the absence of all material changes in the fundus; the patient could only read No. 20 of Jäger's scale. The operation of removal of the gland was performed without the occurrence of any accident, but the inflammatory reaction became so violent, that, in spite of the constant application of ice during eight days, the supervention of meningitis was feared. When after five weeks the wound had healed, the condition of ptosis had not changed. After that time, however, the ptosis gradually disappeared, the eye resumed its normal position and the patient was again able to read the finest print.

XII. G. furnishes a complete history of iridotomy from Thomas Woolhouse, physician to James II., to the present day. According to Mauchart, "Dissertatio de pupillæ phthisi et synizesi," Tubing., 1745, Woolhouse, the teacher of Cheselden, devised and first practised this operation, which he named diæresis iridis. The historical part of G.'s paper is followed by a report of four and a tabulation of fifteen cases operated upon according to Wecker's method of iridotomy, by Rothmund, of Munich.

Of these fifteen cases we may eliminate two, one case of zonular cataract, and one of anterior syrechiæ, both indicating a simple iridotomy. The remaining thirteen, being cases of pupillary closure after linear extraction, required double iridotomy.

From a careful study of this table of thirteen cases we learn that only

in three cases the results were really satisfactory. Five cases demanded a repetition of the operation. In two cases the patients were discharged with a considerable quantity of blood in the anterior chamber. Final result not noted. In three cases a violent reaction ensued, resulting in closure of the pupil and decided diminution of sight. As regards the termination of these three cases the author is significantly silent.

In conclusion, G. expresses the hope that the publication of these cases may tend to reinstate iridotomy to a legitimate position in ophthalmic surgery. Why G., confronted with his own statistics, should cherish this hope, is utterly inconceivable.

OTOLOGICAL PART.

A PECULIAR FORM OF OBSTRUCTION OF THE AUDITORY MEATUS.

PRELIMINARY COMMUNICATION.

(With Figs. 1 and 2, Tab. I.)*

DR. R. WREDEN, OF ST. PETERSBURG, RUSSIA.

(Translated by Charles H. Burnett, M.D., Aural Surgeon to the Presbyterian Hospital in Philadelphia and Surgeon-in-charge of the Philadelphia Infirmary for Diseases of the Ear.)

DURING the last seven years I have seen twelve cases of a peculiar form of obstruction of the external auditory meatus, consisting of a compact mass of histological tissue, which is distinguished from an ordinary mass of cerumen, not only by its macro- as well as micro-scopic properties, but also by a practical and important peculiarity. This peculiarity consists in the excessive toughness of the mass and its pertinacity of hold in the meatus auditorius. Whereas, a plug of cerumen, after a few days of softening by means of an alkaline instillation or a little glycerine, etc., is washed out at one sitting by one to three injections, or in some cases removed *in toto* by means of the forceps. I have never yet succeeded in removing the mass under consideration *in toto*, that is, as a coherent whole or plug, nor even in pieces in one sitting, notwithstanding the fact that I have often used ten strong injections of water consecutively, and that too after using for three days previously a five-gr. solution of soda. The final and complete cleansing of the meatus requires always three to six sittings with an interval of three days, during which time a strong alkaline ear-wash (Natri carbon. gr. viij. x.—xii.—xv. ad. Aq. ℥j.) must be used. It is worthy of note that in cases of this peculiar form of obstruction the first injection, as a rule, brings out only a few softened external layers; that subsequent injections return nothing but clear water. In a case of ordinary ceruminous accumulation the first injection usually

* This table was issued with the first number of this volume.

returns as a more or less brownish water, with a slight admixture of small pieces of cerumen, whereas the second or third injection removes the entire ceruminous mass from the ear.

In a case of obstruction of the auditory meatus, like that under consideration, the entire removal of the mass at one sitting is impossible. In such cases only those layers will be removed which have been acted upon by the alkaline washes, and usually one injection from the syringe will remove all of them thus softened. It is also impossible to remove the mass by the aid of the pincette, for it will break down under pressure of the branches of this instrument, not being enclosed like an ordinary ceruminous mass in a sac, composed of loosened, lamellated epidermis linings of the meatus and the membrana tympani. In these cases we must have great patience, very often indeed, for weeks.

The macroscopic properties of the mass appear at the first glance very different from those of the ordinary ceruminous plug. The mass under consideration has a pale-yellow color and a considerable toughness. Between the fingers it has the consistence of a dry crumbling mass, thus differing greatly from the soft and sticky feeling of ordinary cerumen. Furthermore, it feels dry and not fatty.

Externally it has a very striking resemblance to a piece of Chinese tea-paper folded several times upon itself, so much so, indeed, that in one case, that of a little girl of ten years, I firmly believed the patient had mischievously filled up the external auditory meatus with tea-paper. A microscopic examination, however, convinced me of my error. In order to remove all doubt in a case of this kind, we have but to apply a good lens with a magnifying power of twelve to twenty diameters, in order to recognize very plainly even on the surface of the ejected mass a regular and parallel striation similar to that always found in the epidermis of the external auditory meatus, in consequence of the ridgelike prominence of the papillary bodies of the cutis. The structure of these masses of tissue is lamellar, and similar in all its layers, external as well as internal.

Therefore, it is impossible to confound these compact masses with the well-known tubular formations of skin from the auditory meatus, which in some cases are also filled with cerumen.

By allowing these peculiar masses of tissue to lie in water, we shall also detect a great difference in their behavior from that of cerumen under similar circumstances. Solitary pieces will melt up and loosen themselves with their constituent layers, thus rendering their lamellar structure more evident. In no case do they melt like cerumen into an amorphous pasty mass which gives to the water a brownish color.

The microscope reveals the fact that this obstructive mass is composed, in all its layers, of dry cells of epidermis, and is therefore a product of an excessive exfoliation of the epidermis of the skin of the auditory meatus, produced by a pathological irritation. Among these countless layers of horny epidermis cells may be found, here and there, but comparatively sparsely disseminated masses of yellowish-brown cerumen and hairs from the auditory meatus. I have assiduously looked for spores and mycelium in all these cases, because I thought I might thus find the cause of the pathological irritation of the skin of the auditory meatus, but I have never yet found any such cause in the obstructive mass of tissue, with the exception of one case, which I shall here relate as a unique case. It was as follows :

Tatjana B., from Moscow, 19 years old, consulted me on the 24th October, 1872, on account of hardness of hearing and tinnitus in the right ear. She stated that she had noticed, for several months, that the hearing in the right ear was worse than that in the left ear, but that not until two days before, suddenly in the night, an excessive tinnitus began in the right ear. Supposing that an insect (flea) had crawled into her ear, she had repeatedly poured oil into the affected ear, without, however, the slightest relief. There was no pain, only noise, deafness, and numbness of the right half of the head. The watch was heard 2″ from the ear, and upon the mastoid process. The tuning-fork, placed on the head, was heard very loud in the right ear.

I found, upon examination, the auditory meatus stopped up by a yellowish, firm mass. I ordered the patient to use a solution of carbonate of soda (5 gr. f ℥ i.) three times daily for fifteen minutes, and to return to me in two days. On the 26th of October the patient came to me with no amelioration of the symptoms. The first three injections which I made with the syringe brought nothing from the ear; with the fourth injection several

pieces of an opaque, yellowish mass, with a lamellated structure, came out. This mass closely resembled folded tea-paper, crumbled under pressure of the fingers; presented none of the fatty appearance characteristic of cerumen, but resembled a dry mass of exfoliated epidermis. It was likewise very brittle, so that no large coherent pieces could be removed with the forceps.

Neither was it possible, by repeated injections of water, to remove the mass as a whole plug, but only in little pieces was it finally removed from the ear. It required, in all, fifteen injections, every third or fourth of which brought something from the ear.

After the removal of this remarkably adherent mass from the ear, the membrana tympani appeared slightly opaque from the maceration of the epidermis, and the vessels of the malleus were a little injected; otherwise the ear was perfectly normal. By the removal of the last obstructive false membrane, which presented a cast of the membrana tympani, the intense tinnitus aurium ceased and the hearing became normal.

This mass of organized tissue, removed from the ear, presented all the macro- and micro-scopic appearances already described, as seen in the pieces removed.

After I had settled that point I proceeded to treat the mass with ether, in order to remove the fat and cholesterine of cerumen which had become mixed with it, and thus I was able to gain a much clearer idea of the true nature of the proper constituents of the mass. In this process of removal of fat I found a beautiful and enigmatical vegetable structure, the botanical nature and significance of which are yet entirely unknown to me.

In the literature of mycology I can find nothing similar to it; and yet I claim for my foundling a citizenship in the community of fungi.

The specimen (preserved in glycerine) shows a peculiar, long, double outlined tube, having, at regular intervals, vesicular swellings, and which begins with a large globular protuberance below, and terminates with a smaller egg-shaped one at the point. (Prof. Th. Landzert has most kindly made two drawings of this for me, which are seen in Figs. 1 and 2.)

The width of the tube is, at the base, 0.01716 mm.; in the middle, 0.0143 mm.; and at the point, 0.00858 mm.

The thickness of the wall of the tube = 0.00143 mm. The length of the tube between every two globular swellings is, in the lower portion, 0.06435 mm.; in the middle, 0.0429 mm.; at the point = 0.01287 mm. The vesicular swellings, nine of which may be seen in the specimen, are completely spherical, and have a diameter = 0.04333 mm.; only the incompletely developed terminal protuberance has an ovoid shape, the long diameter of which is equal to 0.02431 mm, and the transverse diameter 0.01716 mm. The surface of these globular swellings is not smooth, but appears, at first sight, to be covered with countless inequalities of two kinds, viz., warts and hairs.

Upon close examination, however, these apparent warts are only the initial portions of the hairs, which, by a change of the focus, may be seen to be an immediate continuation of the warts. The length of the hairs is comparatively very great, being from 0.10153 mm. to 0.06435 mm. to 0.02431 mm. Their width is equal to 0.00429 mm. to 0.00143 mm. The hairs have a double outline. The central canal of the hairs can be seen with a magnifying power of 500 diam., only at their point of exit, *i.e.*, at those portions resembling warts. By the aid of an immersion lens and a very high magnifying power (Fig. 1, $\frac{1150}{1}$) we may see not only the central canal throughout the entire length of the hair, but we also perceive that each hair is supplied with very fine and short hairs over its entire surface. It will also be of interest to mention that the preparation, preserved in glycerine for two ms., displayed the following peculiar changes: it had divided into a number of sections equal to the number of spherical swellings, and from each of the latter several smooth, single outlined tubes had grown, which were much thicker than the above-described hairs. These had grown like wartlets, with varied windings, into the surrounding tissue-mass.

The etiology of this peculiar obstruction, composed of exfoliated epidermis, is very obscure; but, in any event, it is evident that the epidermis of the cutis of the auditory meatus and membrana tympani has been subjected to a pathological irritation, the product of which I shall call *Keratosis obturans*, in order to distinguish it from the ordinary *Ceruminosis obturans*. The cause of this disease is to me unclear, for I dare not suppose that the fungus found in one instance is the pathological irritant in every

case; neither am I able to show that any inflammatory process, with purulent products in the external ear, has ever preceded this enormous exfoliation of epidermis. I have never noted a case of this disease on both sides, but I have found it seven times in the right ear, and five times in the left ear. The patients were four males and eight females. The respective ages were as follows:—

10 to 12 years	6	patients.
20 " 30 "	4	"
30 " 40 "	1	"
40 " 50 "	1	"
Total	12	"

In respect to the subjective symptoms, I would say that all the patients suffered with great deafness and excessive tinnitus. Pain was present in only one case, that of a very nervous man, 46 years old. The prognosis, I can state, is always favorable. All the cases were entirely cured, some of them, however, requiring three to four weeks' treatment. The treatment consists in the preparatory use of a softening, alkaline ear-wash, removal of the softened mass of epidermis by the injection of water, and the subsequent use of solutions of corrosive sublimate or iodine, for the purpose of restoring the cutaneous covering of the auditory meatus to its normal condition.

NEW INVESTIGATIONS UPON THE METHODS OF EXAMINATION AND THE DISTURBANCES OF HEARING.—(*Continued.*)

BY DR. OSKAR WOLF, OF FRANKFORT-ON-THE-MAIN.

(Translated by Dr. D. F. Lincoln, of Boston.)

II.—DISTURBANCES OF HEARING.

THE disturbances which we observe, by following the method previously indicated,* may be classified in the following manner :

1. Direct disturbances of the sound-perceiving apparatus.
2. Combined disturbances of the sound-conducting and the sound-perceiving apparatus.
3. Disturbances of the conducting apparatus.

The clearest clinical picture is presented by the direct disturbances of the sound-perceiving apparatus ; because, in the other two categories, it is not always possible with certainty to separate disturbances of the hearing distance, caused by impediments in the conducting apparatus alone, from those disturbances of perception of sound which are due to the abnormal increase of intra-labyrinthine pressure often found in cases of alteration of the conducting apparatus.

The analysis of the direct disturbances of the sound-perceiving apparatus leads necessarily to a classification of the independent affections of the labyrinth as a whole. I may perhaps be permitted to propose the following as an attempt at such a classification, intended to be practically useful in helping to understand the disturbances of hearing :†

* These Archives, vol. iv., pp. 67–86.

† In making this classification I have pursued the object aimed at by Knapp in his "Analysis of the Inflammatory Affections of the Inner Ear" (these Archives, vol. ii., No. 1, pp. 204–283), namely, the grouping of the cases, partly according to their supposed nature, partly according to their causes. As regards the literature of the subject I would refer to the list there given.

I. Acute Diseases of the Labyrinth:
   a. the hæmorrhagic form;
   b. The form with inflammatory exudation.

II. Chronic Disease of the Labyrinth:
   c. the constitutional form;
   d. the purely nervous form.

In diagnosticating an independent direct affection of the labyrinth, the most important point is the entire exclusion of any affection of the tympanic cavity, past or present. This exclusion is very much assisted by the qualitative speech-test. When, in the case of persons of more or less intelligence, who are able to give a clear statement of their sensations, an affection of hearing appears, the auditory organ having formerly been certainly free (as far as observed) from abnormalities; when in such cases the sound-conducting apparatus, as far as observed by the eye, is found entirely normal; when the nose, tuba and pharynx exhibit no alteration which can be related to the normal discharge of function in the middle ear; when after the air-douche absolutely no improvement in the perception of sound occurs; when the impairment of perception relates chiefly to vocal or other sounds which are well heard at a much greater distance by other patients, even by those who entirely lack the structures of the tympanum* (as, particularly, the Sch-sound, which is so easily distinguished), while other much weaker and more unfavorable sounds are well heard, and at the same time subjective perceptions of sound are or have been present, of a pitch agreeing with that of the sound *not* perceived by the affected ear; when, besides, there exist mechanical injuries or diseases predisposing to rupture of the vascular system or constitutional diseases of those kinds that are frequently localized in the bony tissues—chronic poisoning with mercury, lead or nitrate of silver, rheumatism and gout, syphilis, scrofulosis—or conditions and diseases which are accompanied by transitory or permanent alterations of the nervous system, such as pregnancy, childbirth, typhus and diabetes; *then* I infer the existence of a primary

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* Cf. Sprache und Ohr, p. 149 et seq.

affection of the labyrinth; but not until I have made repeated examinations at intervals of days, and have carefully estimated the patient's powers of hearing by the fork, the voice and the watch.

In selecting the persons for examination those were excluded who were suffering at the time from diseases of the brain or its membranes.

I will here insert three examples, explanatory of the diagnosis of "direct affection of the auditory nerve, or primary disease of the labyrinth;" they belong to the so-called hemorrhagic form.

Although I cannot point to pathologico-anatomical evidence in these cases, as justifying the use of the word "hemorrhagic," yet other observers, as Moos,* Politzer † and Voltolini, ‡ have found extravasations of blood in the labyrinth in similar cases. Knapp § says:

"The occurrence of traumatic hemorrhage in the labyrinth without fracture will not appear improbable, when we recall the hemorrhages within the skull, caused by blows upon the head and eye, and the isolated ruptures of the choroid, which are disconnected with every sort of solution of continuity in the skull or the capsule of the eye."

CASE I.—*Hemorrhage in the labyrinth. Total loss of perception of the sound* F. *Under observation eighteen months.*

Friedrich St., æt. 40, apothecary, consulted me on the 3d of May, 1872. At the Peace Festival of May, 1871, a shot was fired in the room directly behind the left ear of this patient. In a short time he began to perceive a subjective sensation of sound, which remained constant, and resembled a singing sound, tolerably high in the scale; at the same time he observed a considerable loss of hearing power in the left ear, though he had never previously noticed the least abnormal condition

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* Four gunshot injuries of the ear. Archives of Ophth. and Ot., vol. ii., No. 1, pp. 343–356.

† Lesion of the Labyrinth. Ar. f. O., II. Band., p. 88 et seq.

‡ Injury of the head, total deafness, death, autopsy. Monatschrift f. O., 1869, pp. 109–110.

§ Clinical analysis of the inflammatory affections of the inner ear. These Arch., vol. ii., No. 1, p. 204, etc. II. Band., p. 39.

in that ear. No attacks of vertigo. The right ear was found perfectly normal. With the left the watch was not heard until it was laid upon the concha.

The low C^0 fork is heard equally well on both sides, but the A^1 fork less strongly on the left. From the vertex both forks are heard equally on both sides. The quantitative test by the voice showed that on the *left* side words spoken aloud were sometimes understood; at other times the consonants were mistaken at the distance of twenty feet.

I now instituted the *qualitative* test. At the distance of four feet the self-sounding consonants R, B, K, T, S, Sch, and G were distinctly perceived, and even the weak aspirate sound H is distinct; only the F-sound is absolutely not heard. Instead of Fa, Ha is heard, while the syllables Ra, Ka, La, Ma, etc., whispered at the distance of twenty feet, are perfectly distinct.

Inspection and the air-douche showed that the tympanic apparatus was completely normal; no change of condition after the air-douche.

I ordered the continued application of tincture of iodine to the mastoid process, though with small prospect of success, considering the long duration and the constancy of the affection. The last examination was made some months ago, when the same defective perception of sound was observed, and the same troublesome sensations of sound were complained of as at first.

The case is one of irritation, or defective perception on the part of single fibres of the auditory nerve, which was manifested by the continued subjective perception of certain tones of the scale (singing or boiling of tea-kettle), together with incapacity for perceiving the F sound, which possesses a similar quality of tone.

Under these circumstances it will not seem unreasonable to assume that the bodily shock caused the effusion of a small quantity of blood at one point in the labyrinth, followed by a more or less considerable alteration of the nerve-fibres, which correspond to tones of the second octave above. When we also recollect that the lower as well as the higher tones of the scale were perceived with perfect correctness, so that the other nerve-endings must have remained intact, we are enabled to infer from the clinical analysis that the various tones of the scale find their responsive fibres at various points of the labyrinth, separated locally more or less from each other.

A small hemorrhage in a part of the labyrinth will first produce a general lessening of the hearing-distance, through the great increase of intra-auricular pressure; but its principal effect will be to deprive of their functions for the time, and perhaps permanently, those fibres in which it has produced a structural alteration.

The two following cases ran a more favorable course:—

CASE II.—*General diminution of the hearing-distance; especially defective perception, and absence of perception of the sounds of* R, B, K, *and* F; *probably due to congestive hemorrhage. Under observation fifteen months. Complete recovery.*

Mr. H., æt. 23, banker, a healthy, powerful, very intelligent man, had never observed anything abnormal in his ear up to the eve of New Year, 1872. Probably in consequence of unusual indulgence in wine, he felt, on the evening stated, symptoms of great congestion of the head, muscæ volitantes, noise in the ears, headache. On waking the next morning he noticed a very considerable deafness in the *left* ear, while the noises, which seemed to be composed of a series of medium tones of the scale, remained as before. The patient is musical, and plays the 'cello. On the following days the discomfort in the head, the deafness and the noises continued, but there were no attacks of vertigo. On the sixth day he consulted me.

At the first examination the tick of the watch was heard correctly by the right ear, but by the left only at the distance of two inches; from the right temple, very strongly, from the left very weakly. Tuning-fork, both from the external meatus and the vertex, very weak on the left. The conduction by the bones was therefore greatly reduced on the left side.

The quantitative voice-test showed on the right a normal hearing-distance, but on the left words whispered were not heard at all; while words spoken aloud at eight feet were understood in some instances, and in others the consonants were very often confounded.

The qualitative voice-test showed at the distance of four feet—R laryngeale, indistinct; R linguale, not heard; B, not; K, not; T, very distinctly; F and G molle, not; S and Sch, distinctly.

The tympanic apparatus was found normal, by inspection and the air-douche; no change in condition after the latter.

I directed strong applications of tincture of iodine to be made thrice a day to the mastoid process, and complete rest. The patient removed

to a country villa, kept his bowels moderately relaxed by Ofener Bitterwasser, and restricted his diet.

On the 11th of January, 1873, an improvement was already perceptible. The noises seemed to the patient less clear in tone—damped, as if coming from a distance; the sense of constriction of the head was less, and the quantitative hearing-distance had so far improved that certain words were understood when whispered at eight feet; as for the qualitative perception, R linguale, K and G molle were heard plainly at eight feet; while the F sound, as such, was still totally unheard, even when spoken close to the ear. The word "fünfzehn" was not understood at six feet, while the word "sechzehn," whispered at eight feet, was very distinctly heard. Tick of watch heard at six inches.

On the 16th of January the noises had wholly disappeared, while the hearing-distance had increased so much that the patient could converse with me in whispers at the distance of twenty-five feet. Twenty days after the commencement of the affection the ear fulfilled its functions with complete propriety, and up to the present time Mr. H. has had no further trouble, though attending to his business as usual, and taking part daily in the noisy meetings at the Bourse.

I should add one interesting point, namely, the manner in which the F-sound returned after having been lost for twelve days. It appeared on the thirteenth day that the F-sound, as such, could not be distinguished at the distance of four feet, but that S was always repeated instead of F. An explanation of this phenomenon is probably to be sought in the circumstance that the F-sound possesses, besides its fundamental tone A^{II}, a series of higher over-tones, lying in the neighborhood of the pitch of S; it is, therefore, probable that the nerve-fibres concerned regained their functions first, giving rise to perceptions of the over-tones which simulated the S-sound, while the deeper fundamental tone A^{II}, which gives to the F-sound its character, was still wanting.

The present case, therefore, shows us an affection of a series of nerve-fibres, extending over a portion of the scale, appearing suddenly in the midst of health, accompanied by the corresponding subjective sensations of sound, beginning with no other symptoms of nervous trouble besides those of congestion, and disappearing completely within the short space of twenty-one days. In consideration of the fact that this was preceded by the drinking of a

large quantity of wine, and a violent state of congestion, it seems justifiable to assume that the partial loss of hearing was caused by an extravasation of blood in the labyrinth which was reabsorbed within a period not unusual in the case of small hemorrhages. I will not attempt to decide whether any assistance was rendered by the derivative treatment, and the absorbent properties of the iodine. Certainly the course of the disease is incomparably more favorable than that of the former, which was not seen till one year after its commencement.

CASE III.—*Sudden, extreme and general diminution of the hearing-distance of the right ear, probably caused by extravasation of blood in the labyrinth; deafness of old date in the left ear. Under observation eleven months. Relative cure.*

Mr. L., Post-office clerk, æt. twenty-eight, of very vigorous appearance consulted me first on the 15th of September, 1873. His hearing had been bad for some time in his left ear, and this difficulty had increased suddenly, during the campaign of 1870, so that the left ear became useless for the purpose of conversation. This caused him little anxiety, as he continued to hear perfectly well with his other ear, and was not at all impeded in the discharge of his duties at the counter. Such being the case, one may conceive of his consternation when, on the 13th of September, he suddenly heard in his right ear (while in the act of sneezing) a loud noise like a waterfall, and became totally unable to understand the persons who came to the desk. He had also some headache, but *no attacks of dizziness.* At the time, he had some catarrh.

The first examination, made two days after this attack, showed that tone of the C° fork was heard very weakly from the external meatus on the right, not heard on the left; from the vertex, on the right not heard, on the left weakly. Tick of watch not heard from any part of the head.

Quantitative voice-test: Some words are understood with the right ear at the distance of six feet, in others the consonants are mistaken; whispered words not heard at all. On the left some words are repeated with mistakes in the consonants, at two feet distance, but ordinary conversation is so hard to understand that I had to put my questions several times to the patient before he understood them.

Qualitative voice-test: On the right the sounds of R, B, K, T, F are not perceived in the closest neighborhood; Sch is heard instead of S G-molle is heard as merely a weak hissing sound; there is no differenti-

ation of the several hissing sounds from each other. The patient says he hears at present with his (for years almost deaf) left ear, almost better than with the right, which up to the present time has been perfectly well.

Both sound-conducting apparatus appeared free from the slightest fault, as examined by inspection and the air-douche; after the latter the hearing-distance was not altered.

As the patient seemed somewhat congested, I ordered two leeches, to be applied before, and as many behind his right ear, to be let bleed for an hour; perfect rest, remote from every loud noise (the patient lived outside of the city); strong doses of Ofener Bitter-wasser in the morning; restricted diet. On the next day the noises had not diminished, but the hissing-sounds S, Sch, and G-molle were distinguished from one another, while the other consonants were not yet heard. On the 19th strong applications of tincture of iodine were ordered for the mastoid processes; Bitter-wasser continued, two glasses in the morning before breakfast. On the 21st the patient felt somewhat lighter, and the noises were less violent. On the 30th the noise was somewhat less when he walked in the open air, but peculiar phenomena of resonance appeared, namely, an accompanying sound heard during whistling and the singing of high notes. The sounds of R, B, T, F, S, Sch, G-molle are now distinctly heard at four feet. K is not always heard at this distance, but the watch is now heard when applied to the concha.

From this day (the 17th after the attack) the improvement in the nervous apparatus went on very fast; on the 21st day the ticking was heard at four inches, whispers were undertood at ten feet, words spoken aloud more or less at twenty feet. Several sounds, especially the weaker and medium sounds H, K, T, F were not understood separately beyond ten feet. The noises resembled a gentle rustling of wind, and were no longer as sharp and confusing as before.

The phenomena of resonance, and the associated sounds, appeared with the notes C^{II}, d^{II}, e^{II} to g^{II} of the piano. The deep C^{0} fork is now heard from the vertex equally well on both sides.

On the 28th day the power of understanding some whispered words had increased to a range of twenty feet; other words, owing to confusion between the consonants, were not understood beyond ten feet; tick at five inches. No further improvement up to the 44th day; the sound of R and L especially were heard with great difficulty (R linguale and L isolated not over six inches), and the noises corresponded to a deeper tone, resembling rather the distant rolling of a wagon; I therefore ordered iodide of potassium internally in the quantity of from one to one and a

half grammes daily, continuing the former treatment very regularly—gentle laxative doses of Bitter-wasser and tincture of iodine externally.

This increase in the amount of iodine ingested was of undeniable influence upon the absorption of the supposed clot; for after two weeks of the treatment the sounds of R and L were distinguished very clearly at the distance of sixteen feet, while the noises had become weaker, and resembled the rustling of the wind in a forest, and in a few weeks more were often absent for hours together. From the twelfth week after the beginning of the disease no further improvement in the hearing was made, in spite of the most careful attention to orders on the part of the patient. In the fifteenth week he resumed his occupation at the Post-Office. The hearing-distance has remained unaltered—six inches for the watch and twelve feet for a whisper—which was sufficient to enable him to transact the business of his post.

The *left ear* remained quite unaffected by the iodine treatment, neither the sounds of the fork nor the tick of the watch being heard from the outer meatus. The C° fork, placed upon the vertex, was finally heard on the right. When the right ear was closed not one of the consonants was heard by the left ear alone; but vowels spoken loud, and close at hand, were perceived.

To loud noises and to music the patient remained very sensitive, though the associated sounds were not heard.

A residence at the mountain-spring Tölz-Krankenheil, with use of the water containing iodide of sodium, was so far of service that the noises disappeared, and were only observed in the form of a slight pulse-sound during times of great vascular excitement. The hearing distance did not increase, so that at the close of the observation whispered words were heard only at twelve feet, and words spoken aloud at twenty-five feet. Beyond these distances it becomes difficult to understand, especially the sounds of H, B, K, T, F.

For the purpose of defining the exact state of the disturbances of hearing, the present case possesses, as compared with the one preceding it, one great advantage, namely, the elimination of possible self-deception, since the left ear of the patient must be considered as having been deprived of its functions for several years. We know that the bones conduct sound very well; we may at any time make the experiment of closing our ears tightly, and shall find that we can in that condition still hear with distinctness, at the distance of twenty feet, sentences spoken aloud. Whatever the patient heard, he must have heard with the right

ear, for the left reacted not at all, at least not to consonants. I consider the case further valuable, because it is of very rare occurrence that such considerable changes in hearing are caused by violent sneezing. Probably slight hyperæmia already existed, in consequence of the catarrh, which made it easier for the sneeze to cause a rupture of a vessel. It is highly probable that there was a hemorrhage in the nervous apparatus, because an exudation must have had precursory symptoms, and could hardly have given rise so instantaneously to symptoms of increased intra-auricular pressure. The acute form, with inflammation and exudation, presents an essentially different series of symptoms, as the following case will show.

In regard to the course and treatment of the two last cases I should like particularly to remark, that we are called upon to prevent the occurrence of strong impressions upon the hearing, and to avoid all measures which could favor the occurrence of hyperæmia in the direction of the labyrinth, and especially *the air-douche.*

Derivative and absorbent remedies, applied methodically and for a long time, promise some success in recent cases.

Of the *acute inflammatory form of labyrinth disease*, which is chiefly met with in childhood, and is frequently mistaken for meningitis, I will present the following case as a typical instance. The next (fifth) case is here inserted in order to illustrate the difference between the symptoms in direct independent disease of the labyrinth and those in cerebro-spinal meningitis.

CASE IV.—*Acute inflammation of the labyrinth. Complete loss of hearing. Under observation fifteen months.*

Margaretha M., daughter of a tailor in Windecken, æt. 5, previously perfectly healthy, parents likewise healthy. At the end of January, 1872, she was suddenly attacked with chills and heats, headache, and giddiness. On the next morning she could scarcely hear, and complained of all sorts of fearfully tormenting noises—the sound of an organ, human voices, and whistling in both ears; towards afternoon she also vomited. This was repeated whenever she took the least nourishment. *Her consciousness remained perfect;* there was neither retraction of the head (spasm of back of neck) nor strabismus, and in general there were

no symptoms of serious lesion of any nerve-trunk besides that of the auditory nerve. On the third day her hearing had so far diminished that she could not understand those about her, even when they shouted loudly. The vomiting ceased. On the fourth day the fever was gone; the child ate with great appetite; her stools and urine were regular; she wished to get up, but the giddiness prevented her from walking alone. She complained no longer of subjective sensations of sound, so that they had probably disappeared with the increasing paralysis of the auditory nerves. Powerful derivative treatment with local bleeding, calomel and jalap, etc., were without result; continued large doses of iodide of potassium and tincture of iodine were no more successful. The mastoid processes and the nape were painted with iodine, and wet wraps were used to produce powerful sweating. By degrees the child learnt to walk once more alone; but for some time longer she complained of a turning round in her head; her gait remained vacillating, her legs straddled as she walked, like those of sailors on ship-board. Some months later she could walk freely and without dizziness. The loudest sounds close to her produced no impression, neither did the great C° fork placed upon her vertex. The membrana tympani was inspected, and the air douche used, without leading to the discovery of any sort of irregularity of the tympanic cavities.

CASE V.—*Acute Disease of the labyrinth, accompanying cerebro-spinal meningitis. Gradual restoration, with partial recovery of hearing, but loss of perception of the* S-*sound on the right. Under observation two and a half years.*

Dorothea Sch., of Grosskarben, daughter of a day-laborer, æt. 14, was first treated by me on the 3d of February, 1872. She had not yet menstruated, but in other respects was well developed in mind and body. Five months previously, during the prevalence of an epidemic of cerebro-spinal meningitis in her neighborhood, she was taken ill. I had occasion to observe several other children attacked by this epidemic. The disease began with weakness of the limbs, a frequent giving-way of the legs and sinking to the ground, pains in the neck, chills and fever. On the next day the intellect was obscured, speech became difficult, but hearing remained *perfectly good* until the *ninth day*. On this day spasm of the nucha commenced, the bodily temperature rose excessively, and the power of hearing disappeared, while consciousness became more and more impaired. In the fifth week consciousness had been entirely regained. It was still rather hard to speak and swallow, and continual

complaints were made concerning loud noises in the ears, chiefly high tones, like the boiling of water, and hissing.

At the end of the sixth week the other paretic symptoms had disappeared. The child rose, but was unable to keep her balance in walking. The important symptom was observed, that she felt inclinations to fall, sometimes forward, sometimes to one side ; it seemed to her as if everything was turning round in her head. This was still the condition of things when she came to consult me. I owe the foregoing notes to the courtesy of my colleague, Dr. C., who treated her.

When first examined, the tympanic membranes seemed normal on both sides. The air from the douche entered freely and gently.

The tick of the watch was not heard from any part of the skull. The sound of the deep C^0 fork was heard from the vertex, strongly on the right side, that of the A^I fork but weakly ; that of the A^{II} fork not at all. The patient imitated the two former tones correctly by singing. From the outer meatus the C^0 fork was heard but weakly on the left ; the A^I and A^{II} forks not at all. The auditory nerve, therefore, reacted better to low than to high notes.

On the right, all vowels are heard to the distance of five feet, but none of the consonants, so that she could not understand a single word. I found her, however, very intelligent, and easily made her understand in writing the object of testing for distance.

The left ear gave no distinct reaction for any spoken sound. I ordered wet wraps to produce diaphoresis, free pencilling of tinct. iodine upon the mastoid processes and the back of the neck, also iodide of potass., beginning with 0.6 and increasing by 0.2 grammes daily. Diet to be strengthening, with avoidance of fats and of vegetable food as far as possible. The family were instructed to institute a course of stimulating gymnastics (so to speak) for the auditory nerves, by pronouncing certain words slowly and distinctly near the patient's ear. On the fourteenth day after commencing this treatment I was able to note very essential improvements in the condition of the patient. Her entire appearance was better, her eye clearer, her glance more vivacious. She stated that the noises were considerably less, and that she felt freer in her head. She required no further support in walking, though her gait was somewhat uncertain. She understands the meaning of what is spoken to her slowly through the tube-shaped ear-trumpet, or directly into the right ear; certain consonants are, however, wanting, and especially the S-sound.

The manner in which the left ear improved was very interesting. The patient said of her own accord that she began to hear a little better with that ear, and when spoken to through the tube she recognized the

strongest vowels A and O first, while the next in order of power, E and I, were heard only at times, and not quite plainly, while the weakest of all vowels, V, is not yet heard at all. Among the consonants, the combination Ka is distinguished, and no other. It is therefore probable that a uniform increase of pressure had affected the entire left labyrinth (due perhaps to exudation), which was somewhat lessened already by the resorbent treatment, permitting the strongest sounds to appear first, while at the same time the subjective sensations of sound lost much of their intensity.

The doses of iod. potass. were now slowly diminished, and from the twenty-first day onwards 1.8 grammes were taken daily.

Six weeks after beginning of treatment the right ear was tested with the following result. All the vowels are repeated distinctly and correctly. When the consonants R, B, K, T, F, S, G-molle and Sch are pronounced in order, an absence of sound is noticed where the S-sound ought to be heard. This sound is not perceived at all ; it is even absent in the combination Sch, so that instead of Sch, Ch-molle alone is invariably heard. It is therefore probable that precisely the fibres which answer to the pitch of the S-sound remain paralyzed, while those corresponding to the deeper, even if weaker, tones have already begun to act.

In four weeks more, at the time when I exhibited the patient before the medical society,* the hearing of the right ear had so much improved that she could understand whole sentences at the distance of six feet with her back turned. Words containing the S sound, or Sch, were also understood correctly as wholes, while the S-sound alone still gave trouble, and Sch was heard only as Ch-molle.

The left ear had made some (though much less) improvement, so that when it was tested a few weeks later, all the vowels were heard distinctly, as also the combinations Ra, Ma, Na, La, while R, K, B, T by themselves were heard with difficulty, and F, S, and Sch not at all.

At the final examination, two and a half years after the first, the noises had left the right ear, the gait was free and not vacillating, the hearing of the right ear was so far improved that the patient could converse without the aid of an ear-trumpet, although many words, containing difficult combinations of consonants, were troublesome to understand, and the S-sound pronounced alone could not be distinguished. R-linguale and the weak B-sound were perceived extremely well ; K, T and F (pronounced alone) gave greater trouble. In the left ear there are still subjective sensations

* Cf. Jahresbericht über die Verwaltung des Medicinalwesens, die Krankenanstalten und die öffentl. Gesundheitsverhältnisse der Stadt Frankfurt-am-Main. Jahrg. XVI., S. 224.

(as of the rustling of leaves) The patient has developed in the meantime to a robust and healthy young woman, and the functions of menstruation are regularly performed.

The comparison of the two preceding cases furnishes us with certain important points concerning differential diagnosis:

The child M. (Case IV.) is suddenly attacked by fever with violent headache, giddiness and vomiting, which returns for thirty hours whenever she tries to take nourishment. Who would not think at once of the commencement of meningitis? On the other hand, however, the sensorium was entirely free, and during the further progress of the disease, with all the violence we have noted, there is no sort of disturbance of any other nerve-track, no strabismus, no stiffness of the neck; the severe affection of the hearing-apparatus is marked only by fearfully tormenting subjective noises which extend over many series of tones, and are spoken of as organ-sounds, rattling, confused voices, boiling and hissing, probably due to great hyperæmia of the organ. Forty-eight hours after the commencement of the disorder, the consciousness remaining unimpaired, there probably occurs an exudation which causes a total loss of hearing, and while the paralysis of the auditory apparatus makes rapid progress, the subjective noises disappear (by the fourth day), the patient is free from fever, all the other organs and functions of sense are in order, she tastes, sees and feels distinctly, her appetite and stools are in order, and only the disturbance of equilibrium remains for some time longer.

In the other patient (Case V.) the disease begins with less suddenness, and has by no means a violent course. The first symptoms are: disturbances of other nerve-tracks, pains in the limbs, depression, difficulty of swallowing, difficulty of speaking, pains in the neck and throat. The organ of hearing does not seem affected until towards the ninth day, at which time it loses its functions, the patient's consciousness departing at the same time. This phenomenon may, perhaps, be explained after the analogy of neuro-retinitis, in regard to which Knapp states* that it often commences some weeks after the beginning of an attack

* Loco citato.

of cerebro-spinal meningitis, by a gradual extension of inflammation from the arachnoidal cavity along the optic nerve, which leads to atrophy of the latter and loss of sight.

The question of the sense of equilibrium in man, about which there has been of late so much discussion, receives a special light from the facts above stated in regard to the appearance and the gradual disappearance of disturbances of equilibrium in both these cases. The fact that these disturbances were the most severe at their commencement, and disappeared after the subjective perceptions of sound had passed away, speaks in favor of the view recently presented by E. Mach,* according to which such disturbances depend in all probability *upon an irritation rather than a paralysis of the nerves of the ampullæ.* In the course of my own experience I have also had occasion to observe that a tottering gait and attacks of dizziness occur in connection with fresh irritation of the labyrinth, or in relapses of the same, with excessive subjective noises, much oftener and with much more violence than in the later period of anæsthesia of the terminal apparatus. Thus, for example, deaf and dumb persons are perfectly in possession of their balance, and so are the great number of people who have been for years deaf of one ear. It is, however, conceivable that in such cases the semicircular canals retain a tolerably normal amount of function in spite of the severe affection of the cochlea. In support of Purkyne's † view, according to which the maintenance of equilibrium is assisted by the concurrence or the vicarious action of other organs of sense, the following case is presented as offering an interesting pathological contribution. Probably the semicircular canals and those of the cochlea were simultaneously affected.

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* E. Mach: Physikalische Versuche über den Gleichgewichtssinn des Menschen. Sitzungsberichte der kaiserl. Academie der Wissenschaften. III. Abth., Nr. 3, 1873.

† Cf. Purkyne: Beiträge zur näheren Kentniss des Schwindels, Medicin. Jahrb. d. österreich. Staates, VI. B., II. Stuck, S. 79, Wien, 1820. Ueber die physiologische Bedeutung des Schwindels, 2. Bulletin der naturwissenschaftlichen Section der schlesischen Gesellschaft, 1826, S. 1 u. ff.

CASE VI.—*Severe injury to the bone in the region of the mastoid process. Facial paresis. Annihilation of perception of deep tones; retained perception of high tones, especially the* S *and* Sch *sounds; permanent disturbance of equilibrium. Under observation three months.*

Heinrich R., carpenter, of Langendiebach, æt. 35, a very powerful and intelligent man. Seven years ago he received behind the left ear so severe a blow from a stone that he fell to the ground unconscious, and remained so for twelve hours. When he came to himself the left side of his face was paralyzed and his left ear was very deaf. Some days later he perceived a loud noise, humming, the sound of horns, and suffered from continual attacks of dizziness. In the neighborhood of the mastoid process, just behind the concha and at the level of the opening of the external meatus, there was a deep wound implicating the bone, which healed quickly; at the present time there is only a superficial scar of the size of a pea. As to the facial paralysis, which accompanied the injury, the patient said that he was unable for a long time to shut his left eye or to whistle, so that the seat of injury could not have been central, but was in the course of the nerve in the canalis Fallopii. Iodide of potassium was employed internally at that time, tincture of iodine was applied to the mastoid process and electricity was employed; at a later period a hair seton was inserted in the back of the neck. By degrees the paralysis improved, and when I first saw the patient he could whistle perfectly well; there was nothing else to be noted, except a rather strong contraction of the muscles of the left half of the face, especially the risorius. The left ear when first examined presented the following conditions:

Tympanic cavity perfectly normal under inspection and air-douche.

C^{0} fork *not heard;* A^{1} fork heard faintly from the left meatus externus, not at all from the vertex on the left side. Tick of the watch heard on the left from the temple and mastoid process, probably by the agency of the right ear; from the external meatus, not at all. Among the consonants, only the sounds of S and Sch are perceived, but these are heard at a distance of twelve feet, while the others are not heard even when spoken quite close to the ear.

This case possesses a special interest in the disturbances of equilibrium which still attend it, and are probably due to an injury of semicircular canals. At the first, everything seemed turning round towards the *left* ear, and he could not walk alone

without tottering; now, after the lapse of seven years, he is able to walk alone by day and to work, *but when he rises in the morning he is obliged to practise himself for nearly a quarter of an hour before he gains his equilibrium.* It seems, therefore, as if hibituation, the eye, and the impulse of the will might assume a powerful influence over the function of equilibrium. *He cannot walk alone in the dark;* if he tries to do so he is attacked by dizziness and staggers. Music and other tones give him no unpleasant sensations. When loud noises are made (as by a passing wagon) near him, the deep-toned humming and roaring resound loudly in his ears for some minutes; while he is at rest nothing but a slight boiling sound is heard,* but he still has a continuous sense of pressure and fulness in the region of the forehead. The symptoms of irritation of the nervous apparatus on the left side have not, therefore, entirely passed away. The blow probably caused a fissure in the petrous bone, with extravasation of blood, which injured the facial nerve and the semicircular canals, and probably destroyed the great part of the auditory fibres in the cochlea, so that all the tones were lost except the highest, those corresponding to the sounds of S and Sch.

I ordered a repetition of the application of iodine to the mastoid process, but without much hope of success, considering the loss of the greater part of the nervous apparatus of the left ear. After three months I repeated my examination and found the condition of the patient not at all changed.

DISTURBANCES OF HEARING IN CHRONIC DIRECT DISEASE OF THE LABYRINTH.

I have divided these cases into two groups. The first group (the so-called *constitutional* form) contains the cases in which some share of the causation may be assigned to general diseases which are often localized in the bony canals or the periosteum, as rheumatism of the joints or arthritis, chronic poisoning with quicksilver, lead or nitrate of silver, syphilis or scrofulosis, or

* In this respect the case somewhat resembles one observed by Moos. Cf. Pathological Observations on the Physiological Significance of the Higher Musical Tones. These Archives, vol. III., No. 1, p. 113, etc.

else to diseases which produce an alteration in the crasis of the blood or in the nervous system, as pregnancy and child-bearing, typhus and diabetes. The second (the so-called *purely nervous* form) contains the cases in which no general constitutional cause could be traced, but in which other influences, injurious to the auditory nerve, must be supposed to have acted as remote causes of the disease, such as the continued hearing of loud noises, as in the case of musicians, telegraph-operators, locomotive-drivers, tin-workers, locksmiths, blacksmiths; or where, as in affections of other nervous organs, there was no cause to be discovered.

For lack of space I can give but a portion of the cases which illustrate this point.

CASE VII.—*Chronic affections of the labyrinth associated with rheumatic diathesis. Disturbance of perception of the sounds of* F *and* S. *Cure. Under observation two and a half years.*

Mr. N. N., banker, of this city, æt. 58, came under my treatment on the 21st of August, 1871. He had always been well, and looked well, until the last two years, in which he had suffered at times from rheumatic pains, chiefly localized in the left shoulder-joint, for which he had employed lithion-water, colchicum, and hydro-therapeutics with no considerable benefit. Within six to eight months he had suffered from trouble in the *left* ear, consisting in a continual *hissing* sound, of *high pitch*, which gave the greatest annoyance to the patient, who is very musical and is fond of playing the violin. The noises of the day-time, and especially those of the Bourse, increased the hissing for the time being. By degrees he observed that his hearing was less acute on the left side. The air-douche and gargles had been used without success. There was no catarrh of the nose or pharynx.

Both membranæ tympani seemed perfectly normal. My cylinder-watch, which ticks a note quite high in the scale, was heard at normal distance on the right side, but on the left only when applied directly to the concha, and when put on the left temple it seemed as if the tone came from the right. The low C° fork was heard equally well; the A^{1} fork however was heard, from the external meatus, less distinctly on the left side. Whispers are heard on the right at normal distance. The qualitative-test was applied to the left ear by whispers, and the sounds of the piano, violin and 'cello. The result was as follows: Words in connection, whispered, are heard only at ten feet, with considerable de-

ficiencies in the consonant-sounds.* At the distance of six feet the deeper sounds R, B, K, T, G-molle, and all whispered words, are heard plainly, while the higher sounds F and S are entirely wanting, though the S-sound possesses almost four times the power of the K-sound. The counter-test was still more striking; instead of the Sch-sound the patient heard Ch-molle in every case, and the two sounds Sch and Ch-molle give him the impression of one identical sound, that of Ch-molle. The pitch of the subjective perception of hissing is fixed by Mr. N. N. quite accurately at about the end of the third octave above, at which limit the F-sound, pushed to the pitch of A^{III}, approaches the S sound, corresponding nearly to C^{IV}. All of the notes of the piano were heard, and so were the high tones of the violin, which are of course quite penetrating when heard in a chamber, but the feebler sounds from G^{III} to H^{III} of the 'cello were not heard distinctly.† The air-douche entered with a free, gentle current on both sides; after it the subjective noises were louder, but the perceptions of tone were unaltered.

Applications of tincture of iodine to the mastoid process were now ordered, but no immediate change of condition was observed. On the 5th of October the patient went to the cold-water cure at W., in accordance with his annual custom; there the trouble grew worse, for after the douches the noises in the ear grew louder and he suffered from fits of dizziness. At the beginning of December, some weeks after his return from W., I ordered a thorough course of treatment with iodine, which was carried out regularly. He began with 0.6 grm. of iodide of potassium per day, which was by degrees raised to 2.5, and afterwards for eight weeks 1.2 grains per day, until January 30th. The applications of iodine to the mastoid process were continued, and the patient's condition improved a good deal. The hissing grew weaker and was heard only when he exerted himself severely, and finally not at all. The dizziness had disappeared. The perception of sounds began to grow clearer. On the 30th of January iodine-catarrh appeared; the remedy was suspended four days, resumed, and continued till March 31st, at the rate of 0.8 per

* When one ear only is affected, the whispered voice ought to be preferred for exact determinations of hearing, and for the test by series of consonants, because, even when the well ear is firmly closed, it is very easy for mistakes to occur with the loud voice. The well ear, even when its outer meatus is closed, perceives at a considerable distance the sound of what is spoken aloud, owing to the vibratile capacity of the bones of the head.

† Since the timbre and the overtones of the stringed instruments and the piano are very different from those of the F and S sounds produced by blowing, it cannot surprise us to find a difference in the *apparent* sounds when the fundamental sounds are the same.

day. On the date last named whispered words were heard on the left to the distance of forty feet, the sounds of F and S were perfectly distinct at that distance, and the tick of the watch was heard at one foot.

I do not know if I ought to ascribe the remarkable improvement to the effect of iodine alone, but it is certainly striking that, whereas the symptoms grew worse and were complicated by the access of attacks of giddiness before the internal doses of iodide of potassium were given, there was an improvement in every respect, after this remedy had been given, to the point of producing catarrh. I have been confirmed in my belief regarding the effects of iodine by many later observations, and especially by the course which an analogous affection took in the patient's sister, whose case I here transcribe.

CASE XVIII.—*Chronic disease of the labyrinth, with rheumatic diathesis. Impaired perception of the* F*-sound, general diminution of the hearing-distance of the left ear. Severe attacks of dizziness. Improvement. Under observation four years.*

Mrs. P., æt. 40, of Frankfort, came under my care on the 31st of January, 1870. Her appearance was that of fine health—her constitution was very strong. She had had rheumatism in the arms at times. Her last (sixth) confinement took place seven years ago; menses always were regular, except during pregnancies. Until four years ago she never noticed anything out of the way in her hearing, but at that time, 1866, amid the great excitement consequent upon the entrance of the Prussian troops into Frankfort, she felt a sense of pressure in the temples, weariness, etc., which was followed by an attack of dizziness, after which she perceived for the first time a blowing noise (pulse-sounds) in the *left* ear. The attacks of dizziness grew worse, to the extent of producing momentary loss of consciousness, while another subjective sound, a "high-pitched hissing" in the left ear, was heard, which gave extreme discomfort.* The

* She estimated the pitch of the subjective noises, which remained the same during the entire period of my observation, as between e^{ii} and a^{ii}. As will be shown later, the defect in her hearing of sounds related to the F-sound, whose fundamental tone corresponds nearly to a^{ii}. *According to Burnett's observations, when the labyrinthine pressure exceeds a certain limit, the function of the fenestra rotunda is impaired for high tones sooner and much more considerably than for deep tones.* The present case probably involved a great increase of the intra-auricular pressure, which renders it easy to explain the disturbance of hearing.

hearing distance of the left ear became somewhat less. At first the attacks were preceded by a sort of aura, but afterwards they occurred without precursory symptoms; the patient suffered from heaviness and constriction of the head for some time after the attacks. The air-douche injections, and the entire list of irritating remedies applied to the nose and throat, under the care of various aurists, greatly increased the trouble. I, therefore, on first seeing her in 1870, advised her strongly to desist from all treatment of the tympanic cavity supposed to be diseased. The condition at that time was as follows: Tick of watch (left) four inches, whisper distinct to twelve feet, beyond that distance confusion of consonants. Normal hearing on right. Both tympanic membranes normal, free entrance of air-douche on both sides, followed by no change in condition. From the beginning of March, 1870, until April of 1872, the patient paid me no further visits. During this period the disease was described as follows: Constant increase in severity of symptoms; subjective sensation of noises tormenting by day and night; dizziness recurring several times a day; the duration of attacks increasing to as long as a minute at a time. The lady was obliged to give up her intercourse with society, and was not even able to attend properly to her domestic affairs. For half a year she could not write, as the attempt brought on an immediate attack of dizziness. In the meantime she consulted several specialists; they repeated the treatment by the air-douche, which brought on attacks of dizziness and vomiting. In the spring of 1871 she took bromide of potassium by the advice of Politzer, in the amount of from 1.0 to 2.5 grm. per day, in solution; this disagreed with her, producing cardialgia. At this time she became pregnant. As the interval since the last pregnancy had been seven years, the fact was not at first suspected, and she continued to take the medicine for a while without any bad consequences as regards the pregnancy. The trouble in the labyrinth, meantime, remained unaltered, except that the attacks of dizziness were less frequent; and in the beginning of February, 1872, she was delivered of a healthy boy. Ten weeks later she consulted me, and I found the following condition: The subjective noises were still very troublesome. Their pitch was between e^{II} and a^{II}; it included several tones in close proximity on the scale, which consequently were inharmonious; when congestion was present, the pulse-sound was also heard, deeper in pitch, and blowing. The C^0 fork was not heard from the left outer meatus, but from the vertex was heard with increased power on the left. The test by speech showed the very characteristic absence of one consonant and increased difficulty of perceiving several others; the latter might be ascribed to an abnormal increase of intra-auricular pressure, causing by its long dura-

tion a general depression of the excitability of the terminations of the nerve ; the former would correspond to a more completely paralyzed condition of single fibres, which were more severely implicated.

At the distance of four feet she understood whispered speech ; beyond that she confused the consonants. At eight feet the sound of F was not heard at all. Words in which the F-sound occurs once or twice were not understood ; for instance, "fünfzehn." The much weaker sound of B, pronounced alone at the latter distance, was distinctly heard. K, T, S, Sch and G-molle distinct at fifteen feet, but not further. All the vowels distinct to fifty feet ; only U became indistinct at thirty-five feet.

I ordered a course of iodide of potassium, which was kept up steadily during the months of May, June and July, beginning with three pills a day of 0.2 each, combined with extract of taraxacum and powdered licorice, increasing till twelve pills were taken daily, and again diminishing to eight pills. At the same time, warm iodine brine baths twice a week, and abundant application of tinct. iodine to the mastoid processes. Diet very strictly regulated. The iodide of potash was borne in this manner very well for some months. By degrees the patient felt herself considerably relieved. The attacks of dizziness became less frequent and intense, so that, to use her own words, "only a whirl passed through her head at times, compelling her to grasp the table for a moment." At the close of July the last remains of this dizziness had disappeared. The patient was now able to visit the theatre, concerts and social circles ; the hearing distance had on the whole improved, so that whispered words were understood at the distance of ten feet ; beyond ten feet the F-sound first disappeared ; the left auditory nerve was unquestionably defective in its functions. Tick of the watch at ten inches on the left side. Noises weaker ; though still present, they are not very troublesome. March 6, 1873, Mrs. P. is in good looks and feels herself quite well. She spent nearly three weeks in Paris last autumn, exposed to the influence of great physical activity, frequent changes, and mental excitement, without once suffering from dizziness either at that time or since then. The noises had become so faint that she sometimes quite forgot them. Within the last few days she thinks that she hears less distinctly, and that the noises are somewhat more distinct. She describes them quite accurately as the sound of F, and their pitch upon the piano (a^{II}) agrees with this statement. Hearing-distance is as in August last. F-sound not heard at eight feet, while the B-sound remains distinct ; watch at three inches ; K, T, B-linguale distinct at fifteen feet ; S, Sch, G, across the room at thirty feet. Ordered tincture of iodine to the mastoid process.

After two weeks, as the condition had not improved, and slight inclina-

tions to dizziness were remarked once or twice a day, the iodine pills were resumed, and again proved themselves very useful after the lapse of three weeks. At present, after the lapse of another year, the improvement has remained more constant. The defect in hearing has remained, and affects the sound of F chiefly. The hissing is hardly perceived. When it is noticed to be increasing—generally after a period of some weeks of health—or when pressure and tension of the temples are felt, Mrs. P. is accustomed to greet me with the formula, "Is it not time for me to take my pills again?"

CASE IX.—*Chronic disease of the labyrinth. Rheumatic diathesis. Impaired perception of the higher sounds* F, Sch, S, *and* G-*molle. Slight improvement. Under observation a year and a half.*

Mr. Pfl., Secretary of R., æt. 45, a strong, healthy-looking man, and very musical, consulted me at the close of November, 1872. Though previously well, he was attacked seven years ago by a severe acute rheumatism of the left knee-joint; since that time he has heard in his left ear a constant high chirping sound, like that of a cricket. He limits the pitch of this sound, which resembles the hissing of S, to the neighborhood of the end of the third octave above. He observes but a slight diminution in the hearing-distance of the affected ear. The tick of the watch is heard on the right at one inch, on the left when laid upon the concha; whispered speech at normal distance on the right, on the left only to twelve feet. It was found, however, that certain words were understood at a much greater distance, which was ascribed to the fact that the sounds of F, S, Sch, and G-molle, were not distinctly heard beyond this distance, while the lower and much weaker sounds of R, B, K, T, were heard distinctly at the distance of twenty-five feet. There were no attacks or dizziness. The tympanic apparatus on both sides was quite free from abnormality, when tested by the air-douche and inspection; but after the use of the catheter the noises became much louder. After the left mastoid process had been pencilled with tincture of iodine four months, the patient remarked a diminution of the subjective sounds, and said he often ceased to think of them at all. I will not venture to say whether the favorable prognosis which I gave to my very anxious patient (based on the belief that the process of disease had reached a period of repose, for the time at least) was the real cause of this subjective improvement, or whether the latter was due to the use of tincture of iodine.

The slight impairment of hearing which remained and the very faint chirping underwent no further change.

Two cases now follow, in which chronic lead-poisoning was in all probability the cause of the disease of the auditory nervous apparatus.

CASE X.—*Chronic disease of the labyrinth, probably due to saturnism. Defect of perception of the* F *and* S *sounds, with general diminution of hearing-distance. Under observation six weeks.*

Mr. D., manufacturer of porcelain, æt. 42, consulted me on the 28th of November, 1872. Previous to a year and a half ago he had been healthy. At that period he noticed a gradual loss of hearing in the left ear; afterwards he suffered from noises, at first a dull humming, and at present rather a high hissing sound. The right ear was found perfectly normal. On the left the C^0 fork was heard feebly from the external meatus, but from the vertex with increased force. The watch was heard when laid upon the ear, and from the temple. The entire left auditory apparatus exhibited no abnormal condition under inspection and the air-douche; pharynx and nose likewise healthy.

The Voice-test.—Whispered words spoken near the left ear are not understood. Words in connection, spoken aloud, understood at eight feet, but not further.

The test with the series of self-sounding consonants showed that at the distance of eight feet the sounds of R, B, K, T, G-molle and Sch are distinctly perceived, whereas those of F and S can no longer be distinguished from each other, and beyond the distance given F and S are entirely wanting.

From the above assemblage of symptoms I concluded that the case was one of direct disease of the labyrinth, and made inquiry for the cause. As the patient is a manufacturer of porcelain, he has to do with lead, but it was not probable that he had touched the lead glazing with his own hands. He finally, when closely questioned, stated that he had made many investigations with oxide of lead during the past few years, and that he gave daily personal oversight to the work in the factory. His gums showed a distinct lead-line, but there were no other symptoms of lead-poisoning.

I prescribed a mouth-wash containing chlorate of potash, tincture of iodine to the mastoid process, and iodide of potash pills internally. After

six weeks the lead-line on the gums was gone, but the condition of the labyrinth remained the same. I have not seen the patient since that time.

The character of the subjective perception of tones in this case has an acoustic interest. At the beginning of the disease there was a general humming; later there was only a high-pitched hissing, with a striking deficiency of the high sounds F and S. Probably there was at first a general increase of labyrinthine pressure, and subsequently a more special localization of the disease in the higher nerve-fibres, together with general weakening of excitability and perceptivity.

CASE XI.—*Severe affection of the labyrinth in chronic saturnism. No improvement. Under observation four weeks.*

H. M., æt. 42, of Oberwöllstadt, formerly a cooper, now a road-maker, consulted me in October, 1872. He looked very cachectic and prematurely old; had suffered for years with the symptoms of chronic saturnism, heaviness and pains in the limbs, frequent troubles in the mouth, disturbances of digestion, and colic; a hard lead-line appeared on the gums. The trouble in his ears began three or four years ago with tormenting noises in the ears, followed by rapidly increasing deafness. The character of the sounds heard was very various, including the rumbling of the railroad, knocking, hammering, and the tones of organs. Attacks of giddiness were soon added, on account of which he had to give up his trade of cooper, as he was afraid of falling from the platform. At the same time he often had a cloud before his sight and pain in the forehead.

The tympanic apparatus, examined by the douche and by inspection, was found perfectly normal; the nose and throat likewise showed no sign of disease. The ticking of the watch is not heard, either from the temple or from the outer meatus. Sounds of the fork distinct from the vertex, but not from the outer meatus.

Speech is very poorly understood. At the distance of one foot from the left ear the patient hears R laryngeale (spoken vocally) distinctly; he does not hear R linguale, B, K, T, F. He hears S feebly, but Sch (probably on account of its richer timbre) very distinctly; all the vowels distinct. When one speaks slowly, so that the patient can see the face, he understands the words by reading the motions of the lips. On the right he hears only the vocal R and the vowels. The subjective noises

are still troublesome, but the *attacks of dizziness are almost entirely gone.*

I prescribed the treatment by iodide of potassium, although I had little hope of success, considering the existing paralysis of a series of fibres. After four weeks the general health was somewhat improved, but the condition of the labyrinth was unchanged.

From the two preceding cases we are probably entitled to infer that saturnism causes a very rapid and pernicious lesion of the auditory fibres as soon as particles of lead have begun to be deposited in the labyrinth. In the first case the affection of the labyrinth had lasted a year and a half, in the second three or four years, and in both the impairment of hearing was very considerable. The same is true of the diseases of the labyrinth, which are not so very rare in the course of syphilis, although in the latter case I dare not decide how much must be attributed to mercurial treatment, protracted and carelessly carried out, and how much to the disease itself which similarly produces hyperæmia and exudation in the periosteum. It is certain that similar affections of the labyrinth are not rare in laborers who suffer from mercurial cachexia, as cutters of hare-wool.

In the following case no distinct symptoms of syphilis occurred in any other part of the body, either at the time of the labyrinth-disease or subsequently. During this time Mr. R. begat four perfectly healthy children, and yet it is hard to explain the rapid development and the severity of his complaint without assuming as a cause some dyscrasia, as the relics of the lues or the consequences of the protracted mercurial treatment.

CASE XII.—*Chronic labyrinth affection after syphilis, and a protracted mercurial treatment. Considerable gaps in the heraing. Slight improvement. Under observation two years.*

Mr. R., landed proprietor from M., powerful, aged 47, first treated June 5, 1871. Twelve years ago he was infected with syphilis and took a large number of mercurial pills to the point of salivation, afterwards going through the inunction-cure. The only secondary symptoms were psoriasis palmaris, and plaques on the arches of the palate and the tonsils. Two years after the infection another eruption as large as the palm of the hand appeared on the pit of the stomach, after which the patient says he was quite free from eruptions. Two years later he married and

had four healthy children. Eight years ago, after getting heated, and cooling off very rapidly, he noticed violent noises in his right, and subsequently also in his left ear; then deafness came on by degrees, and in three years became so excessive that the patient has had to use a hearing-tube for the past five years. The subjective noises have, on one side, the character of the pulse-sound; on the other that of loud metallic ringing. The fork-sounds, at the first examination, were not heard from the outer meatus on either side, but from the vertex were heard on the right a little. Tick of the watch nowhere perceived. Loud conversation is understood close to the ear, but there are numerous mistakes and loss of various consonants.

With the help of his hearing-tube the patient understands conversation at the distance of six feet, if he can see the person speaking.

Both sound-conducting apparatuses are found in good order, by inspection and the air-douche. Soon after the beginning of his trouble Mr. R. was catheterized by various physicians, but the hearing-distance kept on diminishing instead of improving, and the noises remained unchanged.

I prescribed the iodine treatment which he continued (together with Roman-Irish baths) for six months. In January, 1872, the noises were decidedly weaker, while the hearing-distance for some words and sentences had increased by three feet. The internal use of iodide of potassium was then suspended for three months, and in April was begun anew, when for a second time an improvement occurred, so that the patient understood some words at ten feet without a hearing-tube, other words and series of tones were totally unheard, as in the first examination.

Those fibres, therefore, which were not totally destroyed at the time of commencing the iodine-treatment, had decidedly increased in excitability. The application of tinct. iodine and the Roman-Irish baths were continued till May, 1873. The patient's general condition had much improved, and in especial, his depression of mind (he had been a person of abundant animal spirits before his hearing became impaired) was much relieved by the thought that his complaint had ceased to make progress. The noises in his ears had grown so feeble as no longer to annoy him. The deep C^0 fork is now heard from the outer meatus, but the A^1 fork is not. The deeper tones of the scale seem in general to be preserved, while the higher ones are wanting.

On the right the vowels A and O are heard to forty feet, E to thirty, U to twenty, I only to ten feet. The sounds of R-linguale and K are distinct at two feet, while T, F, S, Sh and G-molle, even when pronounced close to the ear, are not distinguished.

R-laryngeale (pronounced vocally) is heard plainly at the distance of

twenty-five feet. It seems wonderful that the patient should have been able to converse with me at the distance of ten feet, in spite of such deficiencies in perception; the reason is probably this, that he had acquired sufficient practice in reading from the lips to enable him to guess the missing consonants from the position of the mouth and the accent.

That the iodine-treatment under such circumstances had but little effect, was only to be expected from the long course of the disease.

CASE XIII.—*Chronic affection of the labyrinth, following a rapid succession of confinements. Impairment of hearing of deeper tones. Under observation one year.*

Mrs. H., æt. 27, of Offenbach, a powerful woman, always healthy, had four children in rapid succession, and suckled them all herself. A short time after her first confinement she noticed that her hearing was failing, and that when she paid great attention a slight hissing was heard in the left ear. The deafness increased after each confinement, and she suffered from frequent headaches.

She heard worse when she made exertions that sent the blood into her head. There is some ground for affirming an hereditary predisposition, for the mother and the brother are very deaf. The *right* ear is normal in all its parts. On the *left* striking and interesting disturbances exist. Watch heard at one inch.

The low C^0 fork is not heard from the external meatus, the A^1 fork produces a disagreeable whirring in the patient's ear. From the vertex both forks are heard on the right. General hearing-distance two feet for whispers, ten feet for vocal speech with confusion of consonants.

On testing with the series of consonants it is ascertained that the deep R-linguale ceases to be perceived at the distance of six feet, while K, T, F, S, Sch, G, remain distinct at a greater distance.

There is, therefore, a disturbance of perception of the deeper tones.

Mrs. H. is musical, I strike the notes of the piano at the distance of fifteen feet; the limit of perception is at the bass G, and below that point there is no distinct perception while she sings the higher tones correctly after me. I sang the tones, from the bass G down to the bass D, at the distance of eight feet from her ear; she did not distinguish them, while the power of perception is immediately evident from the bass G upwards.

Accordingly, she finds special difficulty in understanding the words in which the deep R-sound occurs; the word "Frau" is not understood at

the distance of eight feet, while the word "Sechszehn," in which no deep tone occurs, is heard very distinctly at sixteen feet. The tympanic apparatus, examined by the air-douche and by inspection, exhibited nothing abnormal.

I ordered the application of tinct. iodine, repose and a stay of four weeks at Rigi-Kaltbad. After her return a slight improvement in the perception of deep tones was observed; this improvement has remained for a year, and no further change has occurred.

I add here one other case which was unfortunately seen but once; perhaps, however, it ought to be recorded, as the account of this peculiar disturbance of hearing accompanying diabetes mellitus, may induce future observers to give attention to alterations of this as well as of other organs of sense occurring in diabetes.

CASE XIV.—L. P., a private gentleman living in Paris, æt.57, consulted me in August, 1871. He had suffered for two and a half years from diabetes mellitus of moderate severity, and during the same period he had also noticed a gradual weakening of hearing, and at times some subjective noises in both ears. The skin and the external auditory passages appeared unusually dry. Both tympanic apparatus, examined by the air-douche and by inspection, appeared normal. The tick of the watch is heard at one-half inch on the right, and on the left when applied to the ear. Whispered words distinctly heard on the right to a distance of fourteen feet, on the left to ten feet. The perception of all the sounds of speech appeared equally weakened so that no confusion of the consonants occurred, nor were there any blanks in the list of tones. After the air-douche the hearing-distance did not change. The patient went to Paris on the next day, so that I did not see him again.

From the second group of cases among which I have placed the so-called "purely nervous form" of labyrinthine disease, I will select only three which present especial interest from a neuropathological point of view.

CASE XV.—*Violent subjective sensations of sound without impairment of hearing in a case of glaucoma of the eye. Spontaneous improvement. Under observation one year.*

L. W., æt. 41, a merchant from Orb, was operated upon for iridectomy on the 20th of February, 1872, by Hofrath *Pagenstecher*, in Wiesbaden.

Both pupils were formed—in the upward direction—very successfully. The patient says that he was always healthy, and particularly that he never suffered from any trouble with the ears. Shortly after the iridectomy he began to hear a very tormenting hissing sound in both ears, which at the time of my first examination was so severe as to deprive him of his sleep. The noise corresponds nearly with the sound of S, but is sometimes accompanied by other lower tones. Inspection and the air-douche failed to show anything wrong in the tympanic apparatus; and no reduction of the hearing-distance for speech or for musical tones or for the watch could be demonstrated. I ordered chloral-hydrate to be taken before bed-time.

One year later Mr. W. came to me and said that he had noticed no diminution of the noises after taking the chloral, and had therefore given it up after a few days; but in the course of the following three weeks he had been pleasurably surprised by finding that the hissing grew weaker from day to day, and in the fourth week disappeared altogether; subsequently it reappeared for brief periods when he was excited and very much heated, but had not been observed during the last few months. The glaucoma has made no progress. He once had some pain in the eye; the visual distance is relatively good; he can read anything with glasses.

CASE XVI.—*Diminution of the hearing-distance and tinnitus, with glaucoma of the eye.*

Princess Sch., æt. 82, from St. Petersburg, was successfully operated upon for iridectomy by Dr. Junker, for the relief of glaucoma two and a half years ago. For the past year and a half she has noticed a considerable impairment of her hearing, which, however, was not very good previously; she also had noises in the ears which she had not previously suffered from; in other respects the patient says her health has always been good. Both tympanic apparatus appear normal as examined by the douche and inspection; the tick of the watch is not heard. Words spoken aloud are heard and understood at the distance of six feet, beyond which the consonants are mistaken. I have not seen the patient again, as she returned soon after to St. Petersburg.

These observations respecting the simultaneous occurrence of glaucoma and disturbances of the auditory nerve were confirmed by Dr. Wreden of St. Petersburg, and others, in the session of the Section for Otiatrics at Wiesbaden. It might be possible to throw some light on the nature of this hitherto dark region

of neuro-pathology, if we should subject the other organs of sense to a similar close scrutiny in cases of glaucomatosis. If we compare the two cases complicated with glaucoma, and the one complicated with diabetes mellitus, we may find the hypothesis of an ultimate central origin not altogether inapposite. Both Hofrath Dr. *Pagenstecher* and Dr. *Steffan* in Frankfort, with whom I conferred in these cases, admitted the possibility that glaucoma of the eye might be connected with changes in innervation, or irritation of the ciliary nerves.*

We are able to trace the nervus acusticus to the floor of the fourth ventricle (Rautengrube), and we know that when this portion of the brain in animals is injured, sugar appears in the urine; the assumption, therefore, of a central cause for the disturbances of hearing in Case XIV. affecting both auditory nerves nearly equally, and associated with diabetes, is not so far-fetched. The hyperæsthesia of the auditory nerve, which appeared in Case XV. (glaucoma) and disappeared of itself without any perceptible disturbance of hearing, and which (most important of all) had affected both auditory nerves alike, is also easier to explain upon the supposition that the original cause was a central irritation in the neighborhood of the origin of the auditory nerves.

CASE XVII.—*Deficient perception of different sounds of speech. Under observation one year.*

Mr. Gl., æt. 50, a private gentleman of literary pursuits in Frankfort, consulted me in February of last year, on account of a gradual diminution of hearing in his left ear, which he had observed to be coming on for a year, and which had begun to excite his apprehension.

He had tinnitus at times. On the whole, he was nervous and depressed from his great mental exertions, though his bodily health had always been good.

The tick of the watch was heard on the right at eight inches, on the left the watch was feebly heard when laid upon the ear. The C^2 and

* By these remarks I do not in the least intend to give an opinion as to the causes of glaucoma, which must of course be left to more competent specialists. I will only quote a passage from Knapp's treatise on the inflammatory affections of the inner ear (l. cit. p. 50): "Serous or hemorrhagic inflammation, with increased intra-auricular pressure, was probably the first stage of the affection of the labyrinth. In glaucoma also, increase of intra-ocular pressure from serous and hemorrhagic inflammation causes first irritation of the optic nerve and then impairment of sight."

A^1 forks are distinctly heard from the outer meatus, but on the left side it seemed to him as if the A^1 fork gave two inharmonious tones, like an impure chord upon the violin (he plays the instrument). From the C° fork he perceives more of the high accessory tones which are produced by the longitudinal vibrations when the instrument is struck. From the vertex both forks sound equally strong on both sides.

The patient is a philologist which made the testing of his power of understanding speech the more interesting.

On the right, words whispered begin to be indistinct at the distance of twenty feet ; on the left the difficulty begins at ten feet for words spoken aloud, while whispered words are in part unintelligible even at two feet. At the distance of four feet from the ear, R linguale, B, K, T, G-molle, are heard distinctly, F indistinctly, and the *sound of* S *not at all*, while Ch molle is always repeated instead of Sch. Thus, the word "Drei" whispered at the distance of four feet is understood, while the word "Sechs" whispered, is not heard at all.

The high tones of the violin in the neighborhood of the fourth octave give the patient a sensation of a disagreeable whirring in his ear.* On the right, the S-sound is not well heard beyond twenty feet ; which induced him, at a certain concert, to criticize a singer (whose pronunciation I knew to be excellent) as not giving a proper sound to his S. When the matter was more carefully tested, the patient had to admit that not the singer was at fault, but his own perceptions.

Nothing abnormal in either tympanic apparatus.

I ordered Mr. Gl. to spend a considerable time in an Alpine climate, to give strength to his nervous system in general ; but he was not able to follow this direction immediately.

After three months the hearing had become much worse on the left side ; even the sounds of T and K could no longer be heard at four inches, and the tick of the watch laid upon the ear was no longer heard. In conditions of mental exhaustion the deficient power of the auditory nerves is now especially prominent.

I will now bring these remarks upon direct affections of the labyrinth to a close by adding some statistical observations.

Direct diseases of the labyrinth, without implication of the tympanic apparatus, are rarer than might seem from the above histories. An assemblage of 1,000 cases of ear-disease gave me

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* Perhaps due to the greater resonance which tones approaching the proper tone of the section "meatus and tympanic membrane" will produce.

30 cases of direct disease of the labyrinth, or 3 per cent.;* of these 24 were males, 6 females. The greatest prevalence was found during the middle period of life: from 30 to 50 years of age sixteen cases occurred.

It is very conceivable that such disturbances of innervation should make their appearance at this time of life, in which men are exposed to the various harmful influences of their trade or of their mode of life, such as the continued hearing of loud tones (in the case of musicians), or of loud noises, which act powerfully on the auditory nerves (as in the case of locomotive drivers, tinsmiths, copper-smiths, boiler-makers, or telegraph-operators); or such influences, commencing in youth, may cause profound nervous alterations in middle life; or deposits of all sorts, both metallic, arthritic, and inflammatory, which might have been gotten rid of in youth by the active processes of disassimilation, at the middle period of life, when resorption becomes less active and tissues less elastic, find difficulty in leaving the body, and therefore produce permanent injuries of the delicate and sensitive parts of the labyrinth. In women the cessation of the menses seems to have some influence upon the changes in the labyrinth. Of the 30 patients, 1 was between 1 and 10 years, 2 between 10 and 20, 4 between 20 and 30, 6 between 30 and 40, 10 between 40 and 50, and only 7 were over 50.

According to profession, the patients were classed as follows:—

2 locomotive-drivers.
2 soldiers.
1 apothecary.
2 telegraph-operators.
1 cooper.
3 copper-smiths and boiler-makers.
3 merchants at the bourse.
2 cutters of hare-wool (mercury).
2 farmers.
1 teacher.
2 shopkeepers.
2 musicians.
——
23

* Knapp found $2\frac{1}{2}$ per cent.

In regard to the results of treatment, I will state that, in general, the first principle is as follows: The more recent the disease, and the sooner we succeed in bringing the entire constitution and mode of life under appropriate treatment, the sooner may we expect improvement or cure to occur. I consider of especial importance *the avoidance of any considerable operative procedure upon the apparatus of the tympanum.* The treatment by iodine, long continued, and combined with the neuro-tonic influence of rest, change of air (the Alpine climate is the best), and iodine-brine baths, or cold friction, etc., is advisable in all those cases which present any indications for iodine, especially since I have never observed that any injury to the general health was produced, even when large doses and protracted treatment were employed.

Of the thirty patients suffering from direct disease of the labyrinth four were cured, eight much improved, ten not improved, and I have no further report concerning eight.

As to the quality of the disturbances of hearing, we find all sorts present, from transitory irritation of a few fibres of the terminations of the nerves to destruction and paralysis of the larger portion of them. The fact that the higher series of tones was more frequently visited by these affections than the middle and lower series is perhaps explicable from the fact already mentioned, that an abnormal increase in the labyrinthine pressure, which, in most cases of disease of the labyrinth, may, from purely anatomical and physical reasons, be assumed to exist interferes with the vibrations of the fenestræ chiefly for the higher tones of the scale.

COMBINED DISTURBANCES OF THE CONDUCTIVE AND OF THE PERCEPTIVE APPARATUS OF HEARING.

Secondary implication of the labyrinth in affections of the middle ear is as common as the direct affection has just been shown to be rare. The essential end of the mobility of the chain of bones being to maintain a minutely regulated and changeable pressure* upon the fluid of the labyrinth, it plainly follows that every morbid change in this regulative apparatus, whether tran-

* Compare the definition in my work, "Sprache und Ohr," p. 227 *et seq.*

sient or permanent, will produce disturbances in the sound-perceiving apparatus. In addition, therefore, to the mechanical impediment which a diseased tympanic apparatus presents to the conduction of sound, there will be also disturbances of hearing, depending (*a*) upon abnormal diminution of the pressure of the labyrinthine fluid, and (*b*) upon abnormal increase of the same.

Disturbances of hearing of the first category, which occur when the loss of membrana tympani, hammer and anvil, or of one of these two bones alone, has deprived the stirrup of the power to exercise a regulative pressure upon the fenestra ovalis, have been previously described by me.*

Those of the second category must be extremely various and hard to isolate, on account of the great variety of diseases and the resulting greater or less disturbance of function in the various parts of the sound-perceiving and sound-conducting apparatus.

Those defined lacunæ in the "tone-picture," which we were able to demonstrate in the cases of direct affection of the labyrinth, are not found in the secondary; although the fact, repeatedly mentioned, that abnormal increase of fluid-pressure in the labyrinth affects chiefly the vibrations for the higher tones has its influence in making the defects more frequent in the perception of the F and S sounds, yet, at the same time, other consonants usually share in the disturbance, especially the deeper and the weaker, on account of the impeded conduction of sound; and the total aspect of the disease, moreover, in regard to its origin, duration, causes, the condition of the tuba and tympanic membrane, and the success of the air-douche, is totally different from that which we meet in direct disease of the labyrinth.

In any case the labyrinthine fluid must be subjected for a very long time to an excess of pressure before permanent and irremediable disturbances of the nervous apparatus occur affecting the hearing.† Usually in recent cases of combined disease the disturbances referrible to the labyrinth disappear very quickly, soon after the position of the ossicula is established. Every aurist is well acquainted with the character of the so-called sclerosis of the

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* Cf. "Sprache und Ohr," p. 149 *et seq.*

† Compare the case of closure of the tuba reported by me, in these Archives, vol. II. No. 2, p. 58, etc.

lining of the tympanic cavity, so that I need not describe it here. Diseases of this cavity, mostly dating from childhood, with alternations of tubal closure and consequent subacute inflammation, lead gradually to adhesions between the ossicula, which are drawn inward, to shortening of the tendon of the tensor tympani, and to permanent increase of fluid pressure in the labyrinth. The patients then become hard of hearing, *i. e.*, one has to speak in a loud tone and raise the voice very much in order to make one's self understood. In these cases it is not usually the conduction of sound that is mainly at fault, but the impaired irritability of the terminal nerve-fibres.

When such a patient suffers from more or less constant tinnitus, when the membrane is drawn inwards and clouded, while no improvement in hearing takes place after the use of the air-douche, and words spoken aloud are defectively heard beyond six or eight feet, then we have to assume a secondary implication of the labyrinth which cannot probably be improved.

The causes of primary disease of the labyrinth have been before enumerated, and especially the injuries which the calling of the patient or his mode of life inflict upon the auditory nervous apparatus, besides the general diseases in the course of which a special tendency to affections of the labyrinth has been shown to exist. All these causes will act much more injuriously upon a labyrinth which is already disturbed in its circulation and nutrition (as a result of the excessive fluid pressure) and therefore is less able to resist the external injury when it comes.

Thus acute serous-inflammatory or hemorrhagic effusions into the labyrinth are far commoner in a diseased labyrinth than in a healthy one ; in typhus, pregnancy, and childbirth, secondary, affections of the labyrinth are very often super added to former affections of the middle ear, and so in syphilis, scrofulosis, and metallic poisoning.

Of the *disturbances of hearing which accompany acute inflammation of the middle ear*, it is easier to draw a typical picture than is the case in chronic affection. In the first two or three days—the stage of hyperæmia—the patient suffers chiefly from beating and pain in the ear affected ; the disturbances of hearing are so slight that whispered words are heard at a considerable distance ; as the process of inflammation goes on the hearing-dis-

tance gradually grows less, and the deafness usually attains its maximum before the perforation of the tympanum occurs, from the fifth to the eighth day. According to the degree in which the labyrinth is then affected, we find various degrees of impairment of perception of speech.

When the vibratility of the sound-conducting apparatus is much weakened by infiltration and exudation the direct conduction through the bones of the head remains so considerable, that, if the labyrinth has not suffered greatly, the patient can understand words spoken aloud at the distance of twenty feet; and the watch can still be heard to tick from the temple. If, therefore, the hearing distance, on the course of the disease, should become as small, that words spoken aloud in the neighborhood of the ear and heard with difficulty, and the tick of the watch is no longer heard from the bones of the head, and if very loud subjective sensations of various groups of tones should be also perceived, then the labyrinth must have become implicated, either through too great fluid-pressure, or through serous infiltration.

When the tympanic apparatus has been properly relieved by spontaneous or artificial removal of the secretion, a moderate improvement in perception is usually observed. During the period of abundant secretion the hearing varies in proportion to the accumulation and discharge of the secretion within the limit that whispered words are hardly understood close to the ear, because the softened and swollen lining of the tympanum has lost the degree of vibratility requisite for weak sounds, and acts as a powerful damper.

Towards the end of the third week the supposed patient usually hears whispers at a distance of several paces. At the moment when the opening in the membrane closes it is usual to observe a considerable diminution of the hearing-distance, and it is not till near the close of the fifth or the sixth week that the parts return to a seemingly normal condition.

This description will answer for a great number of cases, but in some instances there are differences of many sorts, dependent on mechanical conditions, owing to the changes (often rapid) in the degree of impediment to the conduction of sound; the inflammation, too, may of course assume all degrees of severity. In any case the *quality* of the perception of speech is totally

different in the commonest form of otitis media, which is not complicated by severe affections of the labyrinth, from that which exists in direct independent diseases of the labyrinth ; the former affection is accompanied by hindrances to the transmission of sound, which result in a more general and uniform reduction of hearing for *all* sounds, and equally for the watch and the tones of the fork ; in the latter we find a disturbed and deficient reaction on the part of single fibres or series of fibres, with impediments to perception of sound, which denotes an unequal perception of single sounds or groups of sounds in speech ; we encounter "tone-lacunæ." If, for example, the sound of K is distinguished by the normal ear at the distance of 63 paces, and that of S at 170, then the patient, in a certain stage of acute inflammation of the middle ear, hears the K-sound at no more than 6 paces, the S-sound not over 17, while in direct affections of the labyrinth it may happen that the K-sound is heard normally at about 60 paces, while that of S becomes unintelligible at 6 paces.

The careful testing of the hearing-distance in the various stages of acute inflammation of the middle ear is very important in regard to treatment. For instance, at the moment when the perforation of the membrane begins to close, it very often happens that the expected improvement in hearing after the air-douche does not occur, and sometimes there is even a diminution ; it is then time to make longer pauses between the applications of the douche, or to suspend its use altogether ; for a daily continuance, and perhaps a too energetic use, of this remedy might interfere with the formation of a cicatrix, forcibly tear open the holes, or drive the secretions into the cell-spaces of the mastoid processes, and thus easily set up a new inflammation.* In certain cases I have been able to note from day to day an improvement in the hearing distance, after I had entirely abandoned the air-douche at the period in question ; the tubal ventilation had resumed its regular function, thus providing for a spontaneous removal of the secretion which remained, and which had taken the serous-ropy character.

* In this stage I far prefer for adults the careful use of the catheter to the operation of Politzer, because the former enables me to estimate the current of air that is used with much more accuracy.

DISTURBANCES OF HEARING TRACEABLE TO THE CONDUCTING-APPARATUS.

In my former series of experiments on perception* I have already explained a large series of cases of impaired hearing, resulting from simple holes in the tympanic membrane, and have likewise demonstrated in what cases of simple perforation the function of the sound-perceiving apparatus may be considered as unquestionably intact.

On the other hand it is known that in cases of extreme calcification of the membrana tympani a relatively acute hearing is retained. Granulations and small polyps in the external meatus produce disturbances in hearing, if they lie close to the membrana tympani; they may diminish its vibratility by damping it a little; but in cases in which the new-growth does not touch the membrane, and does leave at least a little space in the meatus for the passage of the waves of sound to the membrane, hearing is usually normal. It is rare to observe an echo; of which the following case gives an instance.

C. M., æt. 40, from S., consulted me for deafness which had lasted some months, and purulent discharge from the left ear. He stated that he had a kind of echo in his ear; as he expresses it "he hears the tones first outside, and then after a very short interval a second time, inside of his ear, but the second is duller than the first." He was found to have a rather soft polyp in the outer meatus, the pedicle of which arose from the lower border of the membrana tympani, while its body filled the calibre of the outer meatus so nearly that only about one-quarter of the membrane, of a sickle-shape, remained exposed.

The first, and the more distinct, impression of sound was therefore probably produced by the wave of sound which struck the free edge of the membrane directly; the succeeding and duller sound probably came from a portion of the wave, which was reflected from the polyp upon the tympanic membrane. The polyp was removed by the snare and the phenomenon disappeared.

In my researches upon the conditions of vibration and the

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* Cf. "Sprache und Ohr," p. 93.

resonance of curved membranes I have further shown* that the power of the membrane to strengthen the sound is most effectually reduced when there are impediments in the way of the propagation of its vibrations. The gentle application of a finger to a loudly-resounding membrane is quite sufficient to reduce its resonant power to a minimum. This analogy leads us readily to the conclusion that a foreign body or a plug of cerumen, at the moment when it firmly rests upon the membrana tympani, with some degree of pressure, interferes with the vibrations of the membrane so much that the subject perceives the waves of sound chiefly through the bones of the head, and scarcely at all through the membrana tympani. The bones of the head, however, conduct sound so well, that if the percipient apparatus is intact, words spoken aloud can be heard at the distance of about twenty feet.

But if the foreign body is larger, or has been longer in contact with the membrana tympani, so as to push the ossicula inwards with force, then symptoms of excessive pressure in the fluid of the labyrinth occur, namely, subjective perceptions of sound of all sorts, and a reduction of the hearing distance to such a point that words spoken aloud are usually heard only close to the ear.

The size of the passage of the external meatus does not affect the capacity for hearing; I have found comparatively normal hearing when there was such a degree of stenosis that a fine sound-tip could hardly be forced through.

With this I close my remarks upon disturbances of hearing. They have taken a somewhat dogmatic character towards the close; but I shall be very glad if any of my fellow-specialists would follow out the method of examination which is based on the *qualitative test*, and thus correct and expand my own observations.

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* Loco citato, p. 204.

THE ACOU-OTOSCOPE: AN INSTRUMENT WITH WHICH THE EAR AND EYE MAY BE EMPLOYED AT THE SAME TIME IN MAKING EXAMINATIONS OF THE EUSTACHIAN TUBE AND MEMBRANA TYMPANI.

By THOS. F. RUMBOLD, M.D., St. Louis, Mo.

The difficulty of correctly diagnosing some of the affections of the Eustachian tube and the middle ear, and of observing the influence of their inflation on the membrana tympani during its inspection, led me to attempt the device of an instrument by which the senses of hearing and of seeing could be employed in their examinations at one and the same time. I think that my efforts in this direction were successful. The combination of these two faculties afford greater accuracy than I formerly was able to attain, as the recognition of pathological conditions by one of the senses is now assisted by the use of the other. Wishing to give it a name that will indicate its use, I have called it the acou-otoscope.

I have employed this instrument since 1869 in the examination of all cases where I suspected that the Eustachian tube and membrana tympani were greatly involved, and have found it invaluable in ascertaining the potency of this canal.

Acou-Otoscope (½).

It resembles (see fig.) in form and size a conical ear speculum, with its smaller half cut off. Over the larger end is closely fitted a piece of pane-glass; connecting at one side of this extremity, and opening into it, is a metal tube about five inches long; this tube is for the conduction of sounds from the patient's ear to

those of the aurist; it also serves for a handle by which the patient may hold the apparatus in proper position.

The method of using the instrument is as follows: the smaller end of the conical portion is fitted into one of Gruber's (conical) ear speculums, which is placed in the ear to be examined; one end of an India-rubber tube, eight inches long, is slipped on the long tube or handle, the other end of this is connected to a Camman's stethoscope, the trumpet extremity of which is removed. The patient is instructed how to hold the instruments in his ear in the most favorable position for the aurist to see the membrana tympani; this he is to do with the hand that is on the same side with that of the ear examined; he is requested to avoid making friction with his fingers on the instrument while holding it in his ear, as the slightest movement thus made will occasion sounds far louder than any that might come from his ear during the examination. The aurist now secures his reflector, with which he illuminates the auditory canal, to his forehead, places the stethoscope in his ear, gives the patient a little water to swallow, and while inflating the middle ear by Politzer's method, he is to look through the glass of the acou-otoscope, so that he may observe the effects of the air-douche on the membrana tympani.

In this way he is enabled to hear the sounds produced by the air in its passage through the Eustachian tube, by their being conducted from the patient's ear through the ear-speculum, the acou-otoscope, the rubber tube, and the stethoscope, to his own ear, note their characteristics, and see the movements or other effects on the membrana tympani at the same time.

OTOLOGICAL REVIEW.

By C. J. BLAKE, of Boston.

1. James Hinton. Atlas of the Membrana Tympani, with descriptive text. Being illustrations of Diseases of the Ear. Henry S. King & Co., London, 1874.

2. Max Hubrich. Nervöse Taubheit. *Archiv für Psychiatrie und Nervenkrankheiten.* B. v., H. 1.

3. R. Hagen. Die Percussion des Schädels und deren Bedeutung für die Diagnose von Exsudaten in der Paukenhöhle. *Monatschr. für Ohrenheilk.* October, 1874.

4. A. Politzer. Zur Anatomie des Gehörorgans. Beitrag zur Behandlung der Mittelohraffectionen. K. k. Gesellschaft der Aerzte. Vienna, October, 1874.

5. S. Moos. Beiträge zur normalen und pathologischen Anatomie und zur Physiologie der Eustachischen Röhre. Wiesbaden, C. W. Kreidel, 1874.

6. V. Urbantschitsch. Ein Beitrag zur Entwickelungsgeschichte der Paukenhöhle. *Wiener akad. Sitzungsberichte, Centralblatt.* No. 34, 1847.

7. C. H. Burnett. A Case of movable Exudation in the Tympanic Cavity, attended with variable Hearing. *Medical Times,* October 17, 1874.

I. Among the recent contributions to otological literature in book form, the work which claims first attention, both from the unique character of its design, and the delicacy and accuracy of its execution, is the atlas of Mr. Hinton. That it stands alone in the annals of illustrative contributions to otology, is evident on an examination of the plates to which is appended a descriptive text.

The pictures, one hundred and sixty in number, are executed in water-color by hand, and are arranged as follows—each plate comprising six illustrations.

Plates I. and II., the normal membrana tympani, thinness, opacity, deposits and scars.

Plate III., obstruction of the Eustachian tube and collapse of the membrane.

No. 4 in this plate, representing the right membrane thinned and fallen

in on the promontory and stapes with fine bands extending from the head of the bone, is a good example of the delicacy of handling in the arrangement of the half shadows on the more depressed portions of the inner tympanic wall, and the effect of transparency given to the depressed membrane.

Plates IV. and V., perforations and multiple perforations. The figures in these plates give evidence not only of the delicacy of execution, but also of the accuracy of observation of the artist, the minute details of the changes in the membrana tympani, aside from the perforations which occur as a result of the disease of the middle ear, have received their full share of attention, and the selection of the cases places before the reader a series of the progressive appearances presented by perforation of the membrana tympani in its various stages.

Plates VII. and VIII., perforations healing, complete this series, the changes in form of the openings, the peculiar appearance of the edges, the diffused redness about the opening in some cases, and the marked congestion of individual blood-vessels in others are admirably delineated.

Plate IX., perforations and other diseases.

Plates X. and XI., accumulation of mucus within the tympanum.

Figures 5 and 6 of plate XI. represent the former in a peculiar malformation, consisting of a dense white process of solid bone, running posteriorly from about the short process of the malleus. The patient was a girl ten years of age, with perfect hearing and with musical tastes, the latter, a fracture of the malleus, resulting from direct injury which was followed by intense pain, and almost total loss of hearing, there is apparently a complete separation of the handle of the malleus from the short process.

Plates XII., XIII., XV., XVI., XVII. and XVIII., collection of mucus within the tympanum ; incision. These figures present not only the original appearance, but also the changes which followed incision, and therefore are peculiarly instructive, the variety of the pictures which a fluid accumulation with the tympanum may give is well known to every aural surgeon, and affords a wide field for conjecture to the student. Especial care must have been necessary, and has been accorded to the delineation of these cases ; the effects of gradation in shade and color, and the representation of the changes in form as well as in color being admirably represented.

Figure 6, plate XIV., represents the left membrana tympani of an infant nine months of age after death from geneaal tuberculosis. The membrana tympani being greatly swollen and congested, and of a dirty reddish yellow. The tympanum and mastoid cells contained white semi-

solid masses ; this case appearing to indicate the mode in which destruction of the membrane occurs in strumous children.

Plate XIX., figs. 1 and 2 represent a dense mucous accumulation within the tympanum and the peculiar gaping of the wound, made for the release of the secretion, indicating an abnormal degree of tension of the membrana tympani, the four remaining figures illustrate acute perforation.

Plate XX., exostoses from meatus, membrane and tympanic wall.

Plate XXI., figures 3 to 6, polypi protruding from the tympanum, through a small orifice in the membrana tympani. Figures 1 and 2 polypi growing within the tympanum without perforation, the effect of semi-transparency of the membrane, and of the indistinct outline of the polypi being well rendered.

Plates XXIII., XXIV. and XXV. present a greater detail in their execution, representing, as they do, granular conditions of the membrane, perforations, exudation sacs, sebaceous accumulation and inflammatory disease, accompanied by calcareous degeneration. Figures 1, 2 and 3, plate XXV., represent perforations with granulations in the tympanic cavity, and the accumulation of thickened masses of epidermis upon the membrana tympani, and are good illustrations of the careful attention to minute details which characterizes the work throughout.

Without personal experience in water-color drawing of the membrana tympani, it would be difficult to appreciate the amount of careful labor which this atlas represents. In the completion of the small edition published, not only was it necessary to copy each one of the one hundred and sixty drawings ninety-nine times, but the original drawings have been selected from a much larger number, the preparation of which has extended over a period of seven years. The excellence of their execution has fairly fulfilled the desire of the author, who says in respect to the drawings, "In the first place, I am aware that, through their being done entirely by hand—being water-color drawings in fact—their possible usefulness is greatly limited. But I have been compelled to this course, for in no other way did I find that I could really attain my object, which was to present a series of drawings of the morbid conditions of the membrane which would truly correspond with the objects, and by the study of which a person familiar with the general phenomena of disease might become able to recognize corresponding conditions when presented to him in practice. Having myself had no part in making these drawings (though every one has been carefully compared by me with the originals) I trust I may say of them that they have been, for the most part, executed with a fidelity and perfectness that has at least equalled my most sanguine expectations."

II. Dr. Hubrich adds a page to one of the most meagre chapters in otological literature, and at the same time gives a praiseworthy example of the work which may be done by those having charge of institutions for the treatment of the insane, in throwing some light upon the possible causes of so-called nervous deafness. The paper referred to gives two cases very similar in character, which are reported substantially as follows:

1. M. S. came to the asylum at the age of seventy-four years, and died one year later of senile pneumonia. During a period of thirty years she had received public support as insane. The meagre history showed that she had been deranged, with periodical exacerbations during which she used violent and profane language. The history unfortunately gave no evidence as to the existence of hallucinations of hearing; these were, however, very probably present. Her behavior during her stay in the asylum indicated aural hallucinations; it was frequently noticed that when in bed she would turn her head and whisper toward the edge of the bed; it was very difficult to get any information from her, as she was almost absolutely deaf, but the history gave no information as to the origin or duration of the deafness.

The post-mortem examination showed, in addition to the evidence of a fresh pneumonia, a remarkable softness and friability of all the bones; the ribs could be easily broken between two fingers, and the round bones were readily cut by slight pressure with a knife; the skull was equally soft. Weight of brain 1145 G.; weight of body 42.1 K.

The brain pale and of normal consistence; arachnoidea and pia considerably thickened, the ventricle somewhat enlarged.

No changes apparent in the membrana tympani, tympanum or labyrinth, but the nervi acustici exhibited a peculiar appearance even to the naked eye.

Both nerves were considerably diminished in size, and adherent to adjacent portions of the cerebellum. The left acusticus was particularly degenerated, being hardly a third of the normal size, gelatinously transparent, and of a reddish-gray color.

The microscopic examination exhibited the character of the degeneration more clearly. The first noticeable variation was the great mass of amyloid bodies which, generally nearly circular in outline and having plainly marked concentric striæ, occupied almost the whole field; the remaining structure consisted of wavy connective tissue and empty nerve sheaths. Nerve fibres in which there was a remnant of the centre were rarely visible. The amyloid bodies were found throughout the nerve, partly distributed through the connective tissue or embedded in the

remains of the nerve fibrils, but usually aggregated in masses of from fifty to one hundred.

In the right acusticus the nerve fibrils were more perfectly retained, and hardly distinguishable from those having a normal appearance, but here also were large numbers of amyloid bodies aggregated to such an extent that a single section would cut through four or five nests of them. Sections of various portions of the medulla oblongata showed also large numbers of amyloid bodies, but not aggregated as in the nerves. It is reasonable to suppose that the disease originated where the amyloid bodies were so aggregated, namely in the nervi acustici.

2. M. G., 74 years of age, was brought to the asylum, after a residence of eleven years in the almshouse, from which she was removed to the asylum on account of erotic mania. At the first examination a high grade of deafness was evident; in order to be understood it was necessary to speak loudly close to the ear. The attention of the patient is principally directed to aural hallucinations; she hears threatening words especially, and at each visit inquires as to the reality of her sensation. It is a question as to whether the aural hallucinations are pure hallucinations or are excited in a measure by words imperfectly heard or misunderstood.

The examination of the meatus and membrana tympani gave negative results. Memory and judgment very weak. The patient died after a three years' residence in the institution of facial erysipelas, at the age of seventy-seven years.

The post-mortem examination revealed, in addition to an insignificant œdema of the lower lobes of both lungs, considerable atheroma of the large vessels, fresh ecchymoses and opacities in the endocardium, and small fresh vegetations on the aortic semilunar valves. Weight of the brain 1045 grms. The calvarium considerably thickened, and the sutures partially ossified. Arachnoidea and pia very opaque, brain-substance well nourished and firm. The blood-vessels in the gray substance of the cerebellum were ossified, and projected above the surface on making the section.

The small number of the so-called striæ acusticæ was also particularly noticeable. To the naked eye the nervi acustici were apparently normal both in size and color, but an examination with the microscope revealed a large number of amyloid bodies in both nerves; degeneration of the nerve fibrils was not appreciable, but their function could not have remained unimpaired in the presence of such large deposits as were visible. A further examination of the nerves after hardening in alcohol showed the amyloid bodies to be distributed throughout the whole diameter of the nerve between the nerve fibrils and accumulated in masses. An examina-

tion of the medulla oblongata showed that the disease was not confined to the nervi acustici, for here also, in addition to the general distribution of the amyloid bodies, they were found throughout the medulla aggregated in masses.

Köppe,* in an article on aural hallucinations and diseases of the organ of hearing, has presented a number of cases of interest, and has indicated the relations between the two; the relationship, however, is much more clearly shown when presented together with an examination which clearly shows the nature of the disease affecting the auditory nerve and the parts of the brain near its point of origin.

III. Dr. Hagen gives the results of observations made in his practice on the application of percussion to diagnosis in diseases of the middle ear, his observations being based upon the sensation produced in the ears by percussion of the skull at various points. If percussion is made over the line of the sagittal suture the sound is heard equally in the two ears, provided that both ears are in a normal state. Under the same conditions, percussion upon either side of the median line or over the mastoid results in a greater appreciation of the sound in the ear corresponding to the side of the head operated upon. Stopping one or the other external auditory canal by means of pressure with the finger, or by the introduction of the diagnostic tube, causes the sound to appear louder on that side. Filling the external auditory canal with water has the same result. When the obstruction occurs not without but within the membrana tympani a peculiar symptom is noticed in addition, namely a peculiar tremulous sound in the affected ear. This symptom was noticed in a large number of cases of serous accumulation within the *middle* ear, and the results of the experiment were further confirmed by repeating the percussion after removal of the secretion by means of the instrument of Weber-Liel; in such case the peculiar tremulous sound was no longer noticed; on re-accumulation of the secretion the former symptom returned. The accumulation of less fluid secretions in the middle ear does not produce the same result on percussion of the skull or mastoid.

The reviewer is able to confirm these observations of Dr. Hagen, having himself practiced percussion of the skull, and especially of the mastoid process, and recommended its use in diagnosis in lectures during the past two years. In cases of serous accumulation in the middle ear, percussion of the mastoid causes the perception on the part of the patient of a peculiar metallic sound in the affected ear; this sound may be easily perceived by the surgeon by the use of the diagnostic tube. This observa-

* Allgem. Zeitschrift für Psychiatrie, B. 24, H. 1.

tion, repeated with the same results in a large number of cases of serous accumulation in the middle ear, led to experiments upon the cadaver, the middle ear and mastoid cells being filled with fluid and a connection made between the meatus of the subject and the ear of the observer by means of a rubber tube. The metallic sound observed upon the living subject was in each experiment repeated in the cadaver; when the mastoid cells alone were filled with fluid, the sound was much less marked than when the middle ear was filled to the level of the antrum mastoideum, and was most marked when both cavities were filled with the fluid. The peculiar metallic sound was not observed, or only in a much lesser degree, where the consistency of the fluid was increased beyond that of the ordinary serous accumulation. As the result of his own experience the reviewer would heartily join Dr. Hagen in recommending the practice of percussion to the profession, not only in the cases mentioned, but in such cases of disease of the middle ear as present any of the premonitory symptoms of implication of the mastoid cavity, the accumulation of fluid in that cavity in the earlier stages of disease being sometimes determined by the peculiar symptom above described.

IV. At the meeting of the k. k. Gesellschaft der Aerzte, Vienna, Oct. 16th, 1874, PROF. POLITZER presented a communication concerning the topographical relations of that portion of the temporal bone situated between the middle ear and mastoid portion, with especial reference to the immediate relation of the musculus stapedius to the nervus facialis and the relation of both to the styloid process. In the course of his investigations Prof. Politzer discovered a number of details hitherto undescribed. In the relation of the stapedius muscle to the facial nerve, it was found in the fœtus that only the upper portion of the cavitas stapedii was separated from the facial canal by bone, the lower portion communicating freely with the canal. At this point the tissues surrounding both muscle and nerve are in contact.

In the adult the relation was very varied; an entire separation of the cavitas stapedii from the facial canal, with exception of a small opening for the passage of the nerv. stapedii, is rare.

On the contrary, it is very common to find in the neighborhood of this opening one or more openings from 1 to 4 mm. in size in the posterior wall of the cavitas stapedii, or else the lower portion of this cavity opens by means of a rounded aperture of variable size, into the facial canal on its median wall. The stapedius muscle appears on longitudinal section of a pear-shape, and on cross section triangular, with rounded angles. The fibres arising from the sheath of the muscle extend from the floor and lateral walls of the cavity upward and toward the centre of

the muscle, and pass into the tendon, which may often be traced backward as far as the middle of the muscle.

As concerns the proc. styloideus, in none of the works on anatomy is there to be found a reference to the true origin of this process, or to the termination of its upper portion in the temporal bone. From Prof. Politzer's investigations it appears that the styloid process originates in an individual cartilage formation, which is demonstrable as an isolated cartilaginous body, not only in the fœtus but also in the new-born infant, and that the upper end of the process is found not at the external visible base, but extending upward along the boundary of the external tympanic wall, and separated from the tympanic cavity by a thin bony plate.

In the new-born infant the styloid process exhibits at its upper portion a club-shaped swelling, and below this occasionally a cartilaginous cone projecting more or less in a lateral direction.

In adults the external osseous sheath of the styloid process blends more or less completely with the surrounding mass of bone.

In cases of exudation in the middle ear without severe symptoms, the secretion usually consists of a yellow serous or syrupy fluid, or of tenacious mucus. The spontaneous resorption of such secretion proceeds much more slowly than when the exudation is the result of disease accompanied by more disturbing symptoms, and according to the observation of Prof. Politzer, the secretion may remain weeks, and even months, in the middle ear without being resorbed. In a former communication Politzer has shown that the improvement in hearing, following the use of the air-douche in catarrhal affections of the middle ear, does not result, as has been supposed, from the removal of the secretion accumulated in the middle ear, but from doing away with the abnormal tension of the membrana tympani and ossicula. It has been proven that in the normal position of the head the removal of secretion by means of the Eustachian catheter, or air-douche, is impossible.

On this account Politzer recommended that the head should be inclined toward the side opposite to the affected ear, and slightly forward ; in this position the use of the air-douche was sufficient to free the middle ear, the vertical position of the Eustachian tube allowing the escape of the fluid contained within the middle ear.

A further evidence of the correctness of this supposition, and of the practical value of this method of treatment, has lately been afforded in several cases, in which, after the use of the air-douche with the head in the position indicated, a serous or syrupy fluid flowed in considerable quantity from the corresponding nostril, and an examination of the middle ear showed that cavity to be quite freed from the secretion. Should the

secretion be tenacious, or the mucous membrane of the Eustachian tube much swollen, this method is not likely to prove effectual, and paracentesis of the membrana tympani is indicated, but in simple serous accumulation it will prove sufficient in the majority of cases, and is especially to be recommended on account of its simplicity.

V. S. Moos. The author's investigations, which are presented in a pamphlet of fifty-three pages, illustrated by six handsome lithographic plates, were mostly made upon sections of the frozen parts. The author concludes that the Eustachian tube, when in a state of rest, is closed at a point just behind the funnel-shaped end of the faucial opening, and that the closure extends over about two-fifths of the length of the canal. On the lower surface, or floor of the tube, the closure is effected by the longitudinal folds of mucous membrane, which, as seen in cross-section, form a considerable prominence, literally a valve, the size of which is subject to individual variations. On the opposite surface of the canal, below the cartilaginous hook, there is found in the lower section of the canal another prominence of the mucous membrane, smaller yet visible in section to the naked eye, the occurrence of which has hitherto been overlooked; this prominence, as well as that on the floor of the tube, acquires importance through the numerous analogues occurring in animals, and their function seems to be to facilitate the patescence of the canal by their rapid and easy unrolling.

The author, although differing essentially from previous authorities in respect to the lower segment of the canal, has presented nothing concerning the upper portion, which materially contradicts previous views. A portion of the work of especial interest is that in which is further described the structure of the cartilaginous portion of the tube, and the drawings show a much greater detail in examination and description than has hitherto been accorded to the subject. The "islands of cartilage," mentioned by Zuckerkandl,* are fully described. In regard to size they are divisible into those visible to the naked eye, and those that are microscopic.

In regard to situation they may be divided into five classes, the most important of which are those on the floor of the tube, and those on its sides. The latter have greater importance histologically, as consisting always of fibro-cartilage, and physiologically, as assuming the part of actual sesamoid bones in the mechanism of the tube through their connection with the sub-mucous tissue, the fascia salpingo-pharyngea, and the tendon of the tensor veli palati. This view is supported by the fact

* Cbl. 638, 1874.

that in the horse such a disc of cartilage is found upon which the inner belly of the abductor tubæ finds insertion.

With regard to the division of the tube into "safety tube" and "accessory fissure," the author supports his disapproval of such a division upon reasons drawn from special and comparative anatomy, and gives the following explanation of the physiological action of the muscles of the tube. The tensor veli palati acts directly as a dilator only upon the cartilaginous hook and the neighboring membranous portion of the tube; it acts on the entire membranous portion of the tube only in cases where it is in direct anatomical relation with the sub-mucous tissue, which is not the case when the processes of the fascia salpingo-pharyngea are united with the sub-mucous tissue. Upon the floor of the tube, and that part of the membranous wall which is not drawn away by the direct action of this muscle, it acts indirectly as an abductor tubæ.

The upper and middle constrictors of the pharynx furnish assistance by means of the tendinous processes of the fascia salpingo-pharyngea.*

The author furthermore rejects Rüdinger's view, that the levator veli palati assists in the dilatation of the tube, and bases his opinion upon grounds previously advanced by others, and upon arguments of his own which are derived particularly from the pathological histology of chronic catarrh of the tube.

The appendix of five pages treats of the occurrence of ossified "islands of cartilage" in the human subject, giving the history of the case on which the observations were made, illustrated by a microscopic drawing. An examination of these structures showing a medullary space, bony substance and periosteum, the author's view being that the new formation presents an example of the metaplastic type of ossification, a direct conversion of cartilage tissue into osseous tissue.

VI. Urbantschitsch, as the result of the examination of a large number of embryos, new-born children and infants, arrives at the following conclusions:

In fœtal life there exists a fold which passes from the body and descending process of the incus to the inner wall of the tympanic cavity, enclosing the stapes completely. This fold may begin to disappear before birth, or it may be found perfect even after birth.

The stapes has often been found partially or completely freed from this membrane, while the descending process of the incus remained joined by a complete membranous wall to the inner wall of the tympanic cavity. In this membrane holes appear, which reduce it first to the condition of

* Described by Zuckerkandl, loc. cit.

a bridge, then to fine threads, and these threads may persist for some time—having once been observed in a child four months old. But in many cases the tympanic cavity is found quite free in new-born children, or at most with only a few thready adhesions.

The knowledge of the presence of these adhesions is of practical importance, in order that we may be guarded from making false inferences as to the existence of pathological processes. Such inferences cannot always be justified, as the author has frequently found adhesions of this sort in the tympana of adults without the least evidence of morbid alterations in the tympanic cavity or its membrane.

VII. Dr. Burnett reports a very interesting case in which the symptoms of change of position of secretion in the middle ear were more than ordinarily marked. The patient, a man fifty-five years of age, who had always had good hearing in the left ear, applied for relief from deafness and sensation as of fluid in the ear. The watch (normal hearing-distance forty feet) was heard only six inches, after catheterization the hearing for the watch was doubled, repeated catheterization did not sufficiently relieve the symptoms, and the patient reported that when lying in bed he could hear distinctly, but that arising in the morning there was a sensation as of a drop of fluid in the ear, and the hearing was diminished; following this suggestion the patient was placed in a recumbent position, when the hearing was found to vary with the position assumed, and was found to be doubled when the head was thrown completely backward. Paracentesis liberated a large drop of yellowish serous fluid, with considerable relief from the subjective symptoms, and an increase of hearing for the watch to fifteen feet. At the expiration of forty-eight hours the perforation healed, and the hearing remained normal.

OPHTHALMOLOGICAL PART.

A CASE OF CARCINOMA OF THE OUTER SHEATH OF THE OPTIC NERVE, REMOVED WITH PRESERVATION OF THE EYEBALL.

By H. KNAPP.

(With colored Plates IX. and X., and Lithographic Plates XI. and XII.)

Mrs. Johanna Krämer, 40 years of age, came under my care Aug. 7, 1871, at the N. Y. Ophthalmic and Aural Institute. She had a robust constitution, ruddy complexion, and no symptoms of any general disease, nor had she previously had any illness worth reporting. Her condition Aug. 7th, 1871, was as follows: The left eye was normal in function and structure. The right eye protruded about 5''' forward and slightly downward. This protrusion, she stated, began 6 months previously, steadily increased, and, of late, was accompanied by impairment of the vision of that eye, which, to her mind, had been good before. She had also suffered from occasional headaches, at which times the protrusion of the eye had been greater. The lids closed imperfectly. The movements of the eye were but little restricted inward, more outward and downward, but chiefly upward. No pulsation was felt, no bruit heard on auscultation. There was some injection of the conjunctiva and some lachrymation, but no more than seemed dependent on the exposed condition of the globe. She read J. 14; with + 10 S= $\frac{20}{100}$. The cornea and refracting media were clear, the iris was normal, the pupil responsive to light. The optic disc was markedly swollen, its edges rising abruptly above the level of the surrounding retina. The arteries were lost in the swelling of the disc, and rather small in their course through the retina. The retinal veins were dilated and tortuous. A part of them disappeared at the border of the prominent optic disc, another part crept up and entered tapering into the swollen papilla. The papilla presented an extensive parallactic displacement with the surrounding retina. The disc was grayish-white, the retina beset with a small number of white dots in the region between the disc and the yellow spot. (See Fig. I., Tab. IX.)

I made the diagnosis of a deep-seated orbital tumor, the nature of which I could not ascertain. The slow course of the disease and the headache made me think of an exostosis on the inner-upper region of the

orbital cavity, but the exploration with the finger or probes did not substantiate this diagnosis.

The patient was treated with iodide of potassium for months uninterruptedly, then with calomel, sublimate, biniodide of mercury, occasional leeching. At times there was some improvement of the vision, and the protrusion of the globe appeared less marked ; but these remissions were always followed by aggravations of pain, exophthalmus, and amblyopia. A remarkable feature was the persistence of the ophthalmoscopic picture, which, during the three years the patient was under observation, did not materially change.

After a longer absence the patient came to the clinic again in May, 1874, while I was sick. She was examined by Dr. Gruening, who, under the impression he had received from Dr. Goldzieher's paper "*Ueber Sehnervengeschwülste*" (on tumors of the optic nerve) which had just been published in Graefe's Archives (Vol. xix., No. 3), inferred that the disease might be a myxomatous growth of the optic nerve. When I saw the patient early in June, 1874, I could but concur in the probability of this diagnosis. On palpation a hardish tumor could now be felt on the inner and upper side of the posterior part of the globe. The tumor moved with the eye, and a thin layer of soft tissue was felt between it and the orbital wall. These conditions seemed to prove that the tumor was not adherent to the wall of the orbit, but in close connection with the posterior part of the globe and probably enclosed by the muscles. The globe was dislocated slightly outward, but considerably downward (4‴–5‴). The exophthalmus, determined with an exophthalmometer, was 6‴. Adduction was perfect, whereas the greatest abduction brought the outer corneal margin no nearer than about 2‴ to the external canthus. The eyeball could not be raised above the horizontal median plane, whereas its downward rotation was free. $S = \frac{10}{200}$. F complete. Media clear, pupil movable. The papilla raised, with abrupt borders like a "jockey-cap." Venous hyperæmia marked. The patient was in good health.

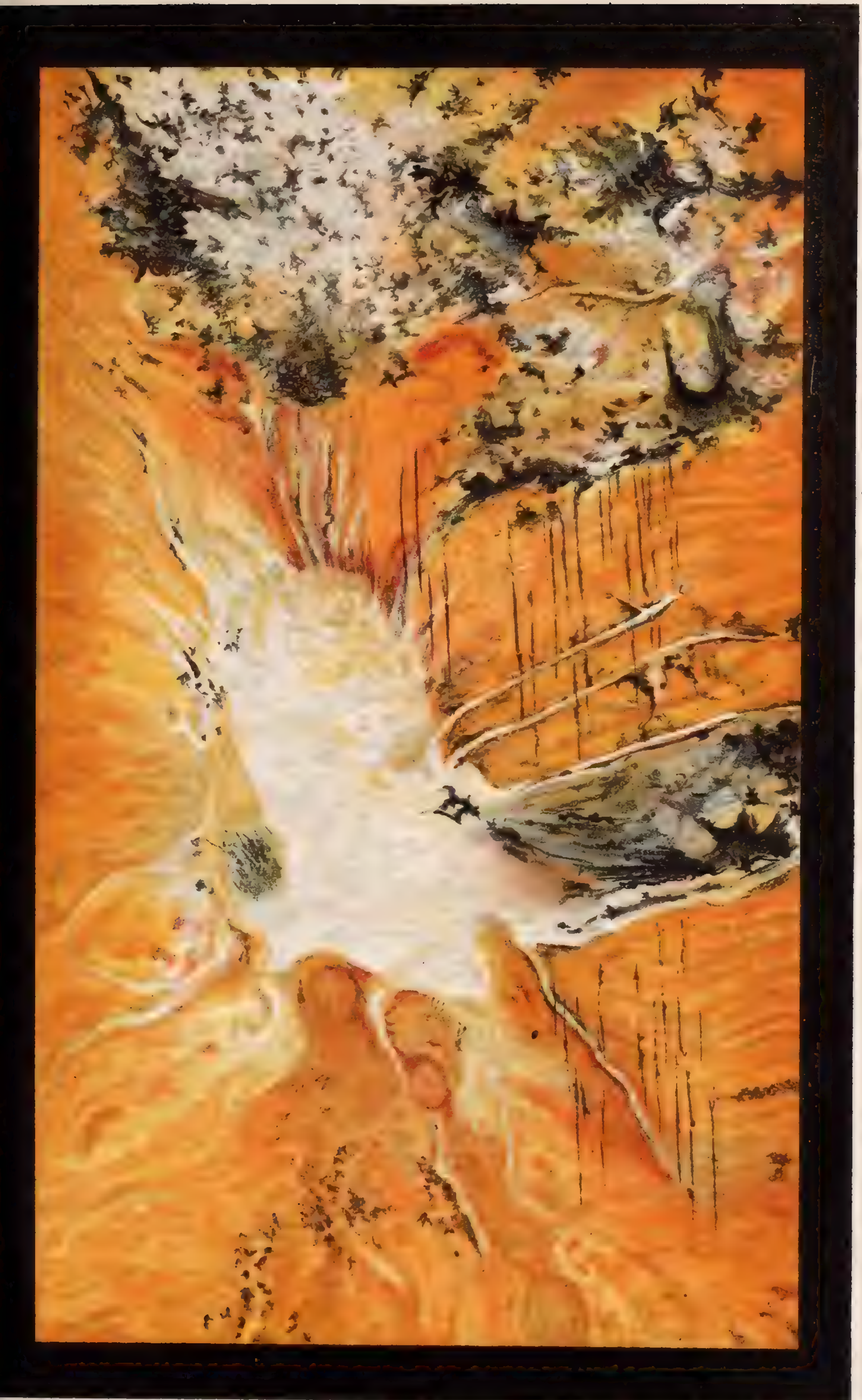
In this condition, on June 10th, 1874, she was anæsthetized, and the enucleation of the tumor, with preservation of the eyeball, attempted and accomplished in the following manner : The lids being kept apart by a wire speculum, I made with a pair of strabismus scissors an opening into the conjunctiva and subconjunctival tissue, two lines behind the corneal margin, between the superior and internal recti muscles, and burrowed more deeply till I reached the tumor. After a portion of the tumor had been laid bare by means of the forceps and scissors, I put the forceps aside and used no other instrument than the scissors for the rest of the

Fig. 1.

H Knapp pinx

Lith v Eschebach & Schaefer Leipzig

Innen.



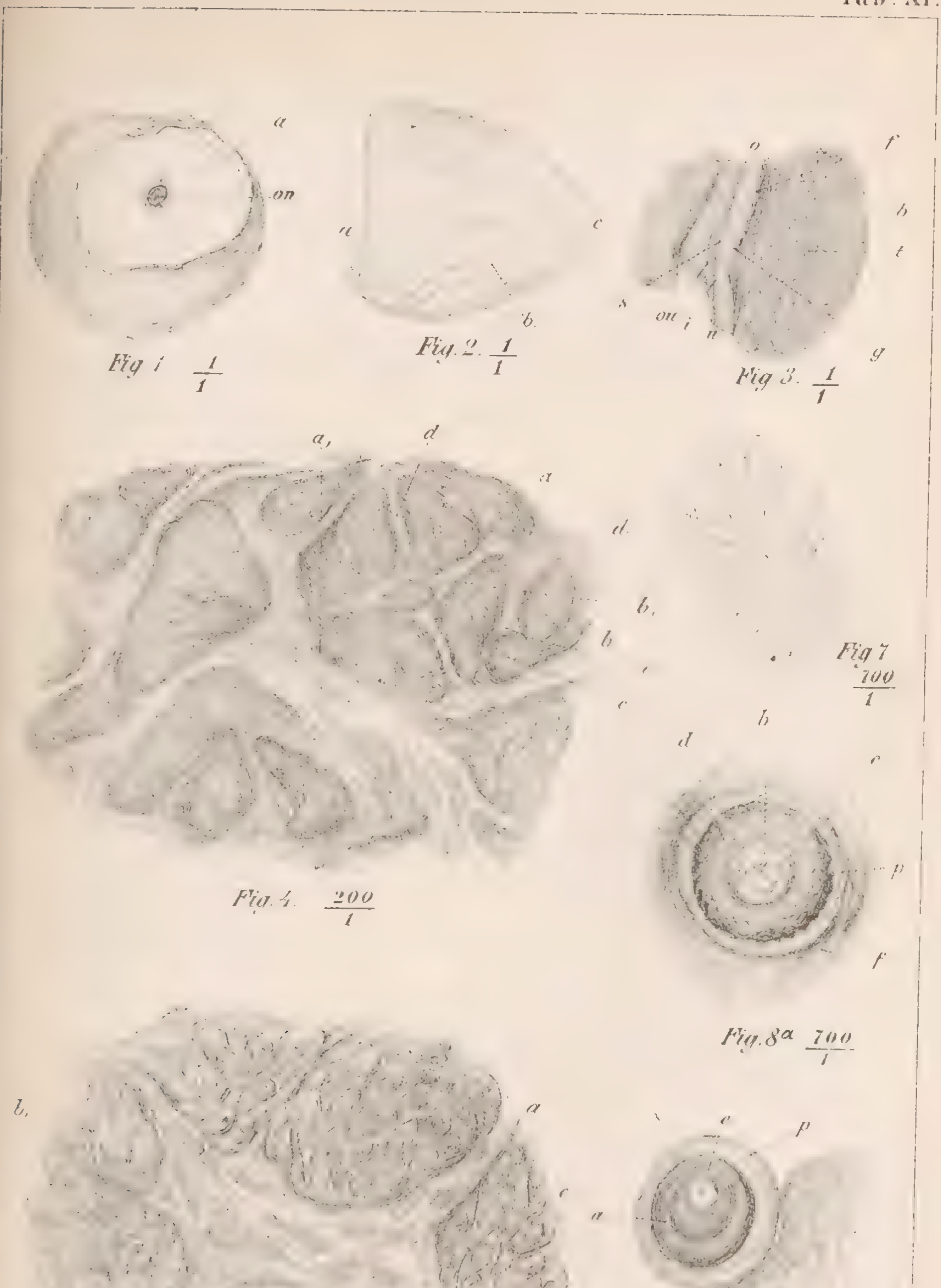
Unten.

Aussen.

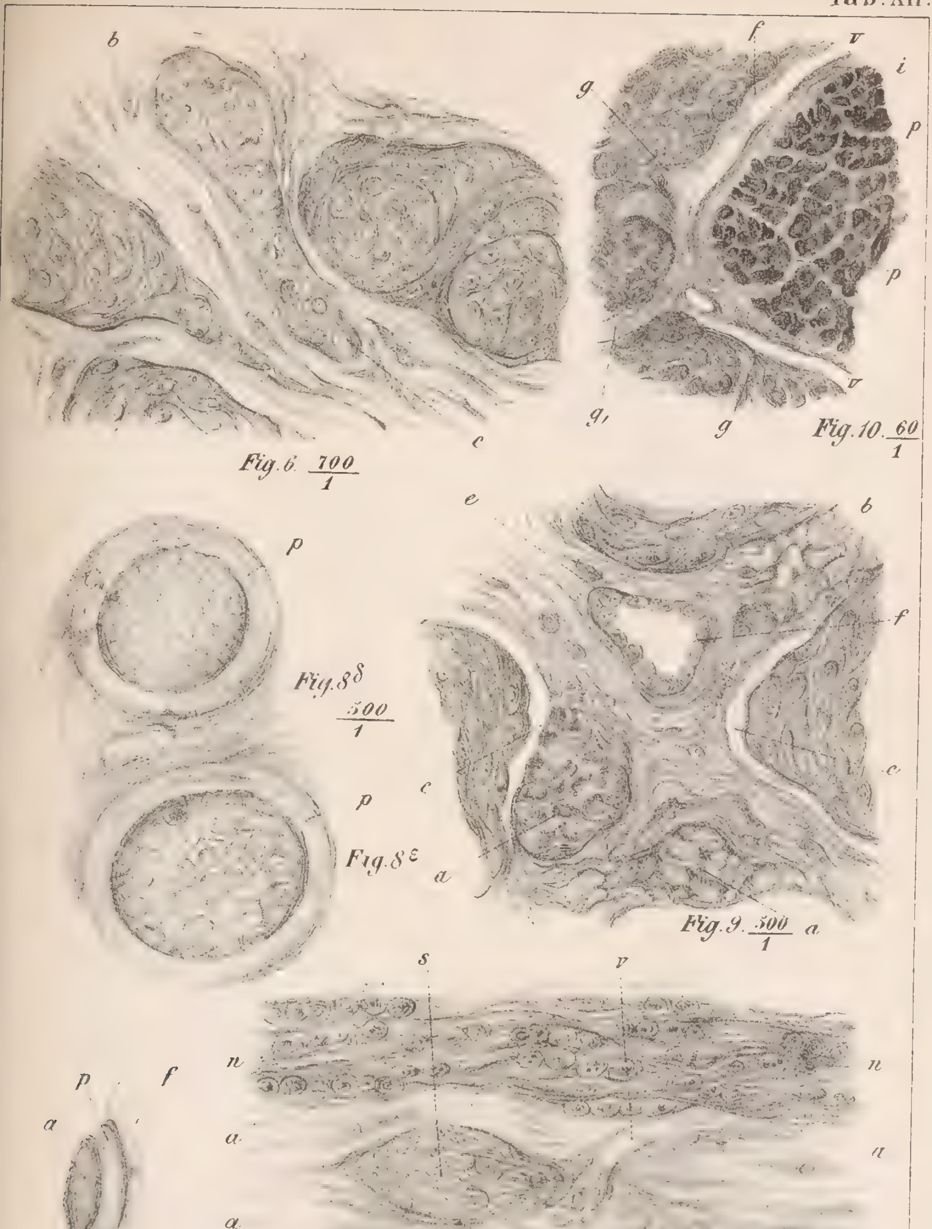
Heitzmann pinx.

Lith. v. Eschebach & Schaefer, Leipzig

Tab: XI.



...pp & Heitzmann del.


b
c
Fig. 6. 700/1
f
v
i
g
p
p
v
g,
g
Fig. 10. 60/1
p
Fig. 8δ 500/1
p
Fig. 8ε
e
b
f
c
c
a
Fig. 9. 500/1 a
s
v
n
n
p
f
a
a
a
a
a
n
n
Fig. 8γ 500/1
Fig. 11
700/1

operation. I introduced my left forefinger into the wound, and under its guidance I detached with the scissors the tumor from the surrounding orbital tissue above, inward, and below. An attempt to discard the scissors and loosen the growth from its surroundings with the sharp end of the handle of a scalpel proved futile. Having isolated the tumor as far backward as I could use my finger as a guide, and finding that I had not reached its end, I had to make room for further procedure. I therefore severed the base of the growth from the sclerotic, which was done by dividing a thin layer of connective tissue interposed between the growth and the eyeball. The optic nerve, easily recognized by its resistance, was divided by one stroke of the scissors, as in the enucleation of the ball. After this I detached the rest of the base of the tumor from the sclerotic. Though, in this procedure, the majority of the posterior ciliary vessels must have been divided, the hemorrhage was only moderate. Without pausing I introduced my left index-finger again as far backward as I could in the narrow space between the tumor and the inner-upper portion of the orbital wall. When I could proceed no farther in isolating the growth in every direction under the guidance of my finger, I introduced a pair of curved scissors, stronger than those used for strabotomy, and cut across the tumor perpendicularly to the axis of the orbital pyramid. I then rotated the anterior portion of the tumor on this axis with my left index-finger, in order to free its outer side from the orbital tissue, which was done by holding the curved scissors first over the upper, then under the lower side of the tumor. After this I opened the branches of the scissors a little, placed them behind the tumor, and lifted it out through the conjunctival opening. Some strings of orbital tissue which had escaped the instrument were now divided, and the bulk of the growth was thus enucleated. I at once reintroduced the forefinger of my left hand and excised, under its guidance, the remainder of the growth which filled the very apex of the orbital cavity, avoiding forcible stretching of the tissue, lest the ophthalmic artery, by retraction into the optic foramen or behind it, remain gaping and cause uncontrollable hemorrhage. I cut, however, so closely to the end of the cavity that the scissors grated on the bone. The whole operation may have lasted about twenty minutes. The hemorrhage which accompanied and followed it was inconsiderable, and scarcely so copious as we find it, on an average, in enucleating the eyeball. During the operation the globe was pushed outward to such a degree that its posterior part rested on the lower and outer edge of the orbit. After the operation it was replaced into its natural location, but nearly as great a protrusion remained as before. I will mention here that the tension of the globe, so far as it could be ascertained with the fingers, was not

diminished. When the hemorrhage was arrested, the upper lid was drawn over the cornea, and the ordinary charpie-flannel bandage applied without exerting any pressure. Before doing so I felt curious to examine the interior of the eye with the ophthalmoscope. I obtained a yellowish reflex from the enlarged and immovable pupil, but no view of the fundus. The reason of this was the irregular detachment of the epithelium from the cornea, which gave the pupillary field the appearance of frosted glass.

Course of Healing.

The patient had smarting pain for five or six hours after the operation, and that was all she suffered. Her headache disappeared with the removal of the tumor. She passed a comfortable night.

The *next* day there was some swelling of the upper lid, and some puffiness of the lower part of the conjunctiva, occasioned by the pressure of the lower lid which did not cover the cornea, but pressed on the equatorial region of the ball. The corneal epithelium had been so far restored that I could dimly see the fundus, which looked uniformly whitish-yellow.

The *third* day after the operation the background of the eye could be clearly seen. It was uniformly milky, showing neither inequalities of surface nor any details. A small whitish-gray infiltration was at the lower border of the cornea. The swelling of lids and conjunctiva had not increased. The lint was moist, but free from pus; in fact, no symptom of suppuration of the wound was present. The same bandage was applied. The whole nasal half of the globe was anæsthetic, and the sensibility of the temporal half, especially of the cornea, was markedly reduced. Tn.

On the *fourth* day the centre of the fundus presented the same milky appearance as before, but the periphery was yellowish-red in every direction. The infiltration at the lower part of the cornea had extended, and an ulcer was in its centre. To obviate any extension of this suppurative keratitis, which I thought had a mechanical origin, namely, the pressure of the lower lid against the globe and the contact of lint with the exposed lower part of the cornea, I closed the palpebral fissure by means of three sutures, two of which were applied to the margins of the lids, the one 1''' beyond the outer corneal margin, the other a line from the inner toward the caruncle. The third suture was passed through the skin of the upper and lower lids without touching the edge of either, and was tied upon the skin. This arrangement was made in order to prevent the threads from pressing on the cornea.

On the *fifth* day from the operation, I found the middle suture tightly stretched, the lids being a little swollen. I cut it, but left the two lateral sutures, which were now sufficient to keep the lower eyelid in position.

The central part of the palpebral fissure could be sufficiently opened, and the upper part of the cornea was clear enough to admit of a satisfactory ophthalmoscopic examination. The milky centre and yellowish-red periphery of the fundus were as the day before, but in the centre there were two dark-red streaks, the direction of which corresponded to that of the upper and lower retinal vessels. They were thickest in their centre, and had tapering ends. No circulation was noticeable. They appeared to be retinal veins. Tn. Sensibility of inner half of globe lost, in outer diminished.

The *sixth* day the swelling of lids and conjunctiva had diminished, the corneal opacity began to clear up, and the ulcer was smaller. The eyeball was more deeply situate in its socket. I cut the inner suture. The red peripheral region had extended, the milky centre was contracted. The two dark-red streaks were longer, and their converging ends very near each other. Four or five other dark-red streaks were visible near the first two, all converging toward a common centre, and radiating mainly in an upward and a downward direction. Undoubtedly they were retinal vessels.

The *seventh* day I cut the last suture. The eyeball had still more receded into its socket. The cornea was clearer. The conjunctiva red, but not swollen. The wound, through which the tumor had been brought out, had closed without ever discharging a drop of pus. The upper lid could not be raised. The globe performed limited upward and downward motions, but no lateral ones. Fifteen to twenty dark-red blood-vessels radiated from the common centre in the background of the eye, but only two actually reached the centre, the others merely pointed toward it. Those which had first been observed were thickest, longest, and very tortuous. The ends of all these vessels could be traced, and the longest did not seem to extend far beyond the equator. The milky opacity was gradually clearing up, and then it greatly resembled the condition which we witness on the fifth or sixth day after embolism of the central retinal artery, namely, the region of the yellow spot being markedly whitish, that around the optic disc faintly opaque, and the periphery red as usual.

On the *eighth* day the outlines of the optic disc were faintly defined, and the character of some of the vessels could be ascertained. Some of the vessels were lighter red, and showed a bright streak in their centre ;

but the majority were dark-red. The light-red vessels, arteries, were small, straight, and few in number.

The *ninth* day the retinal hyperæmia, which was chiefly venous, was more pronounced. No pulsation could be produced by pressure upon the globe. Many vessels were shooting toward the yellow spot, the milky appearance of which was still unchanged. There was no dark-red spot in the region of the macula lutea.

From the *tenth* to the *twelfth* day the venous hyperæmia still increased, and the fundus cleared gradually up. The veins were exceedingly numerous, large, and very tortuous; the arteries had remained small and straight.

On the *fifteenth* day from the operation the patient was discharged from the hospital. The exophthalmus was moderate; the upper lid could be raised a little; the cornea had cleared up. The tension of the eye was normal, the sensibility as above described. The eye moved only very little upward, but extensively downward. Its whole background had become red. The venous hyperæmia was more pronounced than anything I ever saw. The ends of the veins on the disc were so enlarged that they appeared like *varices*, and *thrombosis* seemed to be present.

Three weeks after the operation, I departed for Europe. Drs. MUNSON and GRUENING report that, soon after, extensive retinal hemorrhage occurred in the patient's eye. The retinal hyperæmia gradually disappeared. The disc became white, atrophic, the blood-vessels grew thin and thinner, and were gradually converted into white cords. The extravasated blood disappeared, and left pigment in its stead.

When, after my return, I saw the patient in the latter part of October, 1874, I found her in excellent health. The eyeball was situated a trifle more deeply in the orbit, and was apparently a little smaller than that of the other side, and slightly squinted inward. Mobility upward limited, downward free, laterally absent. The upper lid could be well raised, and both lids opened and closed without effort. The cornea was clear, the pupil large and rigid, the media transparent. The tension of the globe was slightly diminished. The sensibility as before my departure. She had no inconvenience from that eye. There was no trace of a local relapse, nor any symptom of disease in a remote organ.

The other eye was emmetropic and normal in function and structure. The interior of the eye presented a most remarkable picture, which I have watched these three months without seeing it change. The colored drawing (on Tab. X.), made under my supervision by the artistic hand of my friend DR. C. HEITZMANN, illustrates it admirably. In the centre

of the background was a large, shining, white patch, forming an irregular lacework of white strings, enclosing darker spaces. White undulating cords extended from that patch in every direction, losing themselves to the view of the observer before they had reached the equatorial region. The white lacework was newly formed connective tissue lying on the sclerotic. Its centre corresponded to the region of the optic disc. The radiating offsets evidently were obliterated and metamorphosed retinal vessels. At a short distance from the white central patch were large, ii regular accumulations of black pigment, and beyond it (see the left side of the picture which is inverted) the choroid had disappeared, and small, irregular spots of black pigment lay upon the yellowish-white sclerotic. This atrophy of the choroid reached on the nasal side to the end of the ophthalmoscopic field of vision, whereas on the temporal side less pigment, but many irregular patches of choroidal atrophy were seen as far as some distance beyond the region of the yellow spot. Further toward the periphery the fundus showed the normal appearance of the choroid, but no trace of the tissue or blood-vessels of the retina. Below the white patch in the centre (above in the picture) a number of parallel black lines ran horizontally through the fundus, and crossed the retinal as well as choroidal blood-vessels on their inner side. The fundus appeared to be very uneven, yet there were no marked depressions or elevations, since the whole background, when examined optometrically with the ophthalmoscope, was hyperopic $\frac{1}{10}$. Before the operation the patient could read distant print with glasses of about the same strength. At present, eight months after the operation, the condition of the patient is unchanged.

Macroscopic Examination of the Tumor.

The basis with which the tumor rested upon the sclerotic was roundish (*a*, Fig. 1, Tab. XI.), and measured 23 mm. in diameter. It was covered by a thin layer of connective tissue, sepaıating the substance of the pseudoplasm from the sclerotic. Almost in the centre of the basis was the transverse section of the optic nerve (*on*, Fig. 1, Tab. XI.), the dimensions of which were normal. Seen from the side, the tumor presented a conical form (Fig. 2). Its antero-posterior diameter from the base (*a*) to the apex (*c*, Fig. 2) was 30 mm., its vertical diameter 27 mm. I made a section through the centre of the tumor, dividing the optic nerve (*on*, Fig. 3) in its whole length. The section surface

of the pseudoplasm (*t*) was uniformly and finely granular and moderately dense, without any softened or cystic part. The distal portion (*o*) of the optic nerve, *i.e.*, the portion near the eye, was distinctly striated, the proximal end (*n*) was granular, resembling the substance of the tumor. Both the inner (*i*) and the outer (*ou*, Fig. 3) sheath of the nerve were recognizable; the inner sheath presented nothing abnormal, but the outer was disintegrated. On one side—the left in Fig. 3, which was the temporal side in the living—it was thinned and somewhat split into fibres. The intervaginal space (*s*) was filled with a granular substance resembling that of the tumor. On the other—the nasal—side the splitting of the outer sheath into fibres (*f*) was more pronounced, and in the centre it went so far as to destroy the structure of the sheath altogether. In this place the sheath was totally replaced by the substance of the tumor, and the optic nerve was compressed (*g*, Fig. 3). Between the fibres into which the outer sheath was divided, as well as in the subvaginal space, the granular tissue of the tumor was noticeable.

The tumor was covered by a thin layer of connective tissue (*b*, Figs. 2 and 3), which was so uniform and complete that the growth appeared capsulated like the majority of benign tumors.

Microscopic Examination of the Tumor.

Longitudinal and transverse sections taken from all parts of the tumor showed the typical picture of SCIRRHOUS CANCER (Fig. 4, Tab. XI.). A stroma of fasciculated connective tissue enclosed alveoli densely filled with epithelial cells, which had no more intercellular substance between them than was necessary to cement them (Figs. 5 and 7). The alveoli greatly varied in *size*, and, from their arrangement, might be divided into alveoli of primary (aa_1, Fig. 4), secondary (bb_1), and tertiary (cc_1) orders. An alveolus of primary order was surrounded by a thick layer or capsule of connective tissue (a_1, Fig. 4) which sent offsets (*dd*) into the alveolus, thereby dividing it into lobes. From these secondary sheaths smaller offsets (*c*, Fig. 4) were again given off, splitting the lobes into lobules (*c*)—alveoli of tertiary order—and so forth. This irregularity of the alveoli, or rather this

successive division of the lobes into smaller and smaller lobules, apart from other peculiar features, distinguishes alveolar cancer from glandular growths, the lobules of which present greater uniformity.

The *forms* of the alveoli also were somewhat irregular, roundish, oblong, conical, club-like, dumb-bell-shaped, etc., owing to the greater or smaller constriction which, in different directions, the cellular elements of the lobules had to sustain from the enveloping connective tissue.

The *stroma* (Fig. 5), when examined by a high magnifying power, could be dissolved into the elementary parts of connective tissue. The undulating tracts of fibres proved to be spindle-shaped cells with oval or roundish nuclei and long offsets. These cells lay more or less parallel to one another (*a*, Fig. 5), thus producing, for low magnifying powers, the effect of parallel striation. In the immediate vicinity of the epithelial nests the connective-tissue cells were crowded more densely together than in the spaces between the epithelial nests (bb_1 Fig. 5). In these spaces the spindle-shaped cells were less regularly arranged, and a variable quantity of round and slightly oval small corpuscles was scattered between them. They appeared to be the primary elements of which new alveoli were formed, as is seen near *b* in Fig. 5, and at *bc*, Fig. 6. It seemed to me that they were distinguished from the elliptical nuclei of the spindle-cells, and lay loosely in the connective tissue. Whether they formed *in loco*, or were derived from the blood—transuded white blood-corpuscles—is not for me to decide; to judge, however, from their aspects, I should think they were capable of migrating. After aggregating in greater number in one place, they might adhere more firmly to one another, become fixed, and develop into epithelial cells with which we see the alveoli filled.

In Fig. 5 these round corpuscles, or lymphoid cells, or formative elements, or by whatever name we may designate them, lie loosely disseminated in the connective tissue, whereas in Fig. 6, at *b* and *c*, their transition into epithelial cells and the primary stage of development of an epithelial nest are plainly visible.

In the *alveoli* the epithelial character of the cells was well pronounced. The cells were large and flat, had large nuclei, and distinct bright nucleoli. The nuclei and the surrounding proto-

plasm were granulated, the contours of the cells irregular (Fig. 5), and in some places they were serrated. The cells lay closely together, no more intercellular substance being recognizable than a thin layer to cement them together and making the contours appear double (Fig. 5). In some places the cells were as regularly polygonal (Fig. 7) as in pavement epithelium.

On the margin of the growth which bordered on the optic nerve, a small number of very peculiar formations were seen, namely round or slightly ovoid lenticular bodies, which are illustrated by Fig. 8. Their *periphery* (p, Fig. 8) was a bright ring, composed of concentrically arranged fibres like those of fasciculated connective tissue. Their *centre* had one (c, Figs. 8β) or several (c, Fig. 8α) cell-like corpuscles, some of which had nucleoli, others had none. Between the centre and the peripheric ring was a dark-gray or dark-greenish zone (a, Figs. 8β and 8γ), which was either totally (a_1, Fig. 8β) or partially (b, Fig. 8α) divided into concentric layers. The substance between the concentric rings was finely granular, the zone near the peripheric ring (d, Fig. 8α) seemed to consist of coarse granules. These peculiar formations were *arenoid bodies* (sand-globules), such as VIRCHOW has described and depicted. (See his Morbid Tumors, vol. ii., p. 106, etc.) They resemble the brain-sand, which is normally found in the glandula pinealis, the choroid plexus, etc., and pathologically in tumors of the dura mater, which Virchow has termed *psammomata* (sand-tumors). In the specimen before us these *corpora arenacea* were embedded in connective tissue (f, Fig. 8α and β), close to the epithelial nests (Fig. 8β). Some were standing on the edge (Fig. 8γ), showing that they were not flat, but lenticular, with a considerable central elevation.

In the specimen before us these arenoid bodies were only few in number, and limited to the internal border of the pseudoplasm which surrounded the optic nerve. None were found in the bulk or the periphery of the tumor. It is generally admitted that they develop from connective tissue; but some of them, I could hardly doubt, were metamorphosed epithelial nests. The bodies, of which letters β, γ, δ, and ϵ of Fig. 8 give a representation, lay near one another; β and γ were well-developed arenoid bodies, δ was very like it, having a distinct bright

ring (*p*) and a granulated dark centre, pervaded by a system of irregular angular lines. In *ϵ* the connective-tissue ring was likewise distinct, but the centre was filled with epithelioid cells. Addition of muriatic acid produced no gas-bubbles, but changed the granular appearance of the contents of these bodies in such a way that cellular elements could be recognized, the character of which, however, whether epithelial or desmoid, was not clearly defined.

The whole growth was *very vascular*. Smaller and larger blood-vessels branched through the stroma in every direction, but never entered the accumulations of epithelial cells. The walls of the vessels were generally thin, in the larger vessels a fibrous coat (*f*, Fig. 9) was well defined and lined with a regular layer of endothelial cells (*e*, Fig. 9). The capillary vessels had more or less homogeneous walls. From the capillaries we had to distinguish curved and empty canals (*c*, Fig. 9), which, without any walls, separated the epithelial nests from the stroma. These canals were artificial, produced by the separation of the connective tissue from the accumulation of epithelial cells during the hardening of the specimen, in which process each tissue contracted towards its own centre.

Another system of canals was visible in some places; on the sides of the smaller blood-vessels there was a space well enough defined both from the wall of the blood-vessel on the one side, and the connective tissue on the other. These canals were partially empty, partially filled with lymph corpuscles, thus manifesting themselves as *lymphatics*. I could only demonstrate their presence on the sides of the blood-vessels (representing what His had perhaps improperly called circumvascular sheaths), but I was not able to trace their course into the accumulations of the epithelial cells, as MM. *Cornil* and *Ranvier* have done.

A marked feature in the specimen was the *colloid degeneration* of the stroma. In many parts the colloid substance was so abundant as to occupy large portions of the stroma, which in itself was more developed in these parts than in others. The colloid substance appeared in round or egg-shaped globules of the smallest size to that of a small epithelial cell. The colloid corpuscles were homogeneous in structure, hyaline and shining, and resisted to reagents, of which I particularly mention iodine, sul-

phuric acid, and muriatic acid, in order to show that we had not to deal with amyloid formations or chalky concretions. The smaller part of them was scattered irregularly through the stroma, one or a few corpuscles lying isolated in the connective tissue, the larger part was crowded together in roundish clusters (*a*, Fig. 9), or in winding tracts (*b*, Fig. 9) following the stroma of the cancer. It is generally acknowledged that the colloid substance is a degenerative metamorphosis of the connective tissue, and of frequent occurrence in cancers. Our specimen illustrates this in a typical manner. The colloid substance was totally absent in the epithelial accumulations, but very abundant and in all degrees of development in the stroma.

The connection of the growth with the sheaths of the optic nerve was one of its most important features. The outer sheath, as I have observed in the macroscopic description of the tumor, was more or less disintegrated in different places. Its fibres were crowded asunder, and apparently separated by the cellular elements of the neoplasm. The boundary of the neoplasm toward the subvaginal space (*vv*, Fig. 10) was formed by dense fibrous tissue (*f*, Fig. 10), which was the remnant of the outer sheath of the nerve. At the temporal side of the nerve (*ou*, Fig. 3) it formed a thick coat, whereas at the nasal side (*f* and *g*, Fig. 3) its splitting into fibres had advanced so far as to leave at one place (*g*, Fig. 3) no more fibrous tissue than we saw between the lobules of the cancer. In all places the outer sheath gave off fibre-bundles ($g\ g_1$, Fig. 10), which constituted the stroma of the pseudoplasm as regularly as the offsets of the inner sheath (*i*, Fig. 10) constituted the perineurium internum (*p*, Fig. 10), the communicating partition walls between the bundles of nervous fibres. The fibres of the outer sheath were infiltrated with lymphoid corpuscles, the same as we have seen in the stroma of the cancer, which accumulated in some places to form the beginning of epithelial nests. The tracts of fibrous tissue which originated in the outer sheath presented, by their continuous divisions and subdivisions, an elegant framework which, in the neighborhood of the nerve, was arborescent, but became irregularly undulating in the remoter portions of the tumor. The *subvaginal space* in most places was pervaded by the well-known cordlike fibres of elastic tissue. In some of them *microscopic nodules* were seen, which consisted of colloid corpuscles.

The endothelium with which these elastic cords are covered, could be well demonstrated without particular preparation by reagents. Some of the endothelial cells had been detached. They were large, irregular in outline, wrinkled, and each had a distinct oval nucleus.

The *intervaginal or*, as SCHWALBE terms it, *subvaginal space* showed nothing abnormal in some places ; in others the elastic fibres were clogged with clusters of colloid globules, as we have seen, and in others, again, it was densely filled with cancer substance, the walls of the alveoli touching the inner sheath of the nerve.

The *inner sheath of the optic nerve* was thickened, and infiltrated with colloid and lymphoid bodies, but nowhere did I find in it cells of an epithelial character.

The *perineurium internum* in the neighborhood of the inner sheath was infiltrated with a greater quantity of lymphoid corpuscles than usual, but in the interior of the nerve it appeared normal (*aa*, Fig. 11). Its fibres were delicate, undulating, and bright, contrasting with the darker and broader nervous fibres (*nn*, Fig. 11). Blood-vessels (*v*, Fig. 11) of normal appearance ran through the interstitial connective tissue of the nerve (perineurium int.).

The *nervous fibre-bundles* (*nn*, Fig. 11) were very distinct. The only pathological change observable in them—which, however, was very marked—was a more or less dense infiltration with lymphoid cells throughout the whole course of the nerve. At its proximal end this infiltration was densest, the cells being aggregated between the nervous fibres in single and multiple rows, and in clusters ; at the distal end, of which Fig. 11 gives an illustration, the lymphoid cells were sparser, yet so numerous as to form shorter and longer strings.

These lymphoid cells could not histologically be distinguished from the nuclei which, in the normal state, are scattered irregularly among the fibrillæ of every nerve. In the specimen before us, however, their abundance and peculiar arrangement in rows and clusters characterized them as pathological products, and, in particular, as products of inflammation. In Fig. 11 a primitive fibre-bundle—the one in the centre—was cut obliquely, so that a transverse section of it was exhibited (*s*, Fig. 11) show-

ing an accumulation of cells not unlike an alveolus. The cells, however, were small, lymphoid, and had interstices between them. They could not be compared to epithelioid formations. In no place of the whole nerve have I been able to find anything like epithelial clusters. I may, therefore, state that the pseudoplasm as such did not invade the optic nerve, though it certainly was the cause of the inflammatory changes in the nerve.

These changes were evidently propagated to the *intra-ocular end of the nerve*, where they produced the picture of that variety of choked disc which VON GRAEFE first styled *neuritis optica descendens*, assuming that the inflammation travelled from the cerebral or orbital part of the nerve into the eye. I do not recollect whether he substantiated this statement by anatomo-pathological specimens, or whether he made it as a logical postulatum. The case under consideration, which has been preceded by some others, anatomically confirms the existence of true neuritis descendens. The elevation of the intra-ocular end of the optic nerve, we may fairly assume, resulted from the presence of the same small round cells which we found so abundantly infiltrated in the nerve, furthermore from the pressure upon the blood-vessels of the nerve, which was the cause of the contraction of the arteries, the dilatation of the veins, and the serous exudation into the tissue.

The *periphery of the tumor* was surrounded by connective tissue which was condensed by being crowded together. It consisted of fibres and fat, was likewise infiltrated with small round corpuscles, and in close vicinity of the tumor rows of epithelial cells, parting from the tumor, extended into it.

REMARKS.

Many points of unusual interest are connected with the case just described. Some of them which have not been dwelt upon, should not remain undiscussed.

In regard to the symptoms and course of the disease, I think that it was impossible to make the *diagnosis* with any degree of certainty before the growth had so far advanced as to be accessible to the touch. The main points upon which the diagnosis

was based were the following: 1, The intimate connection of the growth with the posterior part of the eyeball; 2, the interspace between it and the walls of the orbit; 3, the combined and uniform motions of the tumor and the eyeball. The absence of a pseudoplasm within the eye, as proved by the ophthalmoscope, was of importance, showing that we had not to deal with the extension of an intra-ocular tumor.

The preservation of available sight ($S = \frac{10}{200}$) and of a complete visual field, demonstrating that the optic nerve was not destroyed, made it probable that the growth did not originate in the nerve nor had penetrated deeply into it, but sprang either from the tissues in the subvaginal space or from the outer sheath. The cases which Goldzieher describes (Graefe's Arch., xix., 3, p. 119, etc.) illustrate the fact that in tumors originating in the sheaths of the nerve, or in the subvaginal space, the nerve itself may run either through the substance or over the surface of the tumor, and still more or less preserve its integrity. Of JACOBSON'S case, which NEUMANN describes, it is said (Arch. der Heilkunde, xiii., p. 310), "the vision was hardly diminished." In this case, as in ours, the pseudoplasm sprang from the outer sheath and surrounded the nerve.

The *ophthalmoscopic condition of the optic disc*, the peculiar feature of which was the abrupt elevation of the borders of the swollen papilla and the limitation of the swelling almost to the area of the disc, may be of diagnostic value, yet I would make no other deduction from it than that it indicated an infiltration of the disc with solid tissue elements: cells and their derivatives. A serous exudation must necessarily, it seems, produce an elevation with sloping borders, extending over the adjacent retina. A solid infiltration, depending on the propagation of an inflammatory or hyperplastic process along the nerve into the eye, may produce either a steep and circumscribed elevation of the disc, or a sloping and extended intumescence; but a serous infiltration seems to be capable of producing a gradually sloping and extended elevation only. If further observations confirm the truth of this remark, a steep and limited choked disc would refer to a proliferating extra-ocular process. As to whether it indicates an orbital or an intracranial process can mostly be determined by other symptoms, such as protrusion of the eye, disturbances

of mobility, etc. Von Graefe also mentions the steep elevation of the papilla in his cases (his Arch. Vol. x., 1, p. 194), and in one the elevation occupied only half the area of the disc. The examination of the specimen derived from this case showed that the tumor had developed on one side of the nerve, destroyed a part of its fibres, while the other part passed uninjured over the periphery of the tumor.

Limitation of the visual field has been observed in cases in which the neoplasm originated in the inner sheath and destroyed a part of the nerve.

The *course* of development of all the tumors of the optic nerve that are on record has been very slow, two years (a case of Szokalski) being the shortest time from the visible beginning of the growth to its removal.

The *greater portion of the tumor* in the case under observation, as in all the others, as far as the description mentions it, was situated on the *nasal side of the nerve*, making its first appearance between the inner and superior recti. The mobility toward the nasal side was free in all cases, whereas there was a limitation of motion, either outward, or upward, or downward, or in different directions at the same time. In two cases (Graefe's), it is stated that the protrusion was about in the direction of the axis of the orbital pyramid, and that the motions of the globe were possible, yet limited, in every direction. In our case and in the majority of the others, the protrusion was downward and outward, and in this direction was also the greatest limitation of the motion. In orbital tumors, if I am well informed, the opposite condition prevails: the mobility is most reduced toward the side of the tumor, and greatest in the direction of the protrusion. If, for instance, a tumor is located on the nasal side of the orbital cavity, the protrusion of the globe is forward and outward, and its inward rotation (adduction) is more limited than its outward rotation.

In our case the tumor moved with the eye, or I might say was moved by the eye. This symptom led to the supposition that the tumor was in intimate connection with the eyeball, and the operation showed that it rested with a broad basis on the sclerotic. GRAEFE stated that in his cases the eyeball turned on its physiological centre of rotation, and inferred from this fact that a consid-

erable amount of yielding connective tissue must have separated the growth from the globe. This inference was confirmed by the examination of the specimens, which presented conditions like the instructive first figure in Goldzieher's paper.

The *specific nature* of the tumor was not diagnosticated, in fact not even thought of. That real carcinomata of the optic nerve existed was not known to me. In the cases on record the mucoid tissue played such a prominent part that it either represented the bulk of the growth (myxomata, mucoid cysts) or was abundantly dispersed through its texture. The majority of the tumors of the optic nerve on record originated in the inner sheath, and are of a muco-fibrous character. One, the second of *Goldzieher*, was a glioma, originating, according to the author, in the subvaginal space; and two cases, that of *Neumann*, and the third of *Goldzieher*, were sarcomatous and psammomatous, probably originating in the outer sheath. Neumann's tumor consisted in part of compact tissue: fibres, fat, and an abundance of cells (sarcoma), in part of an alveolar texture, in which arenaceous bodies were so prevailing that the tumor might be styled a psammoma. Neumann leaves it undecided whether, since the tumor contained fat, it originated in the orbit, and extended to the optic nerve, or whether it primarily developed in the outer sheath of the nerve. In our case the origin of the growth in the outer sheath cannot well be doubted. Its nature, being truly cancerous, is very remarkable. I abstain from all theories on the mode of development of cancerous growths, but would mention that the lids, the conjunctiva, the exterior and interior of the eye, and the lachrymal gland appeared entirely normal, nor was or is there any symptom of the presence of cancer in any other part of the body. DEMARQUAIS (Tumeurs de l'Orbite. 1860), LEBERT (Maladies Cancéreuses, p. 841), and GALEZONSKI (Maladies des Yeux, 2d éd., 1875, p. 607), mention cases of scirrhous cancer of the optic nerve, but I have not been able to verify the diagnosis from the description. I have, however, not yet consulted the above-mentioned treatise of Lebert, in the original. SZOKALSKI'S observation, "Tumeur squirrho-cancéreuse du Nerf optique," published in the Ann. d'Oculist., in 1861 (tome 46, p. 43, etc.), is very important in a clinical point of view. It occurred in a child of four years of age. The tumor

was first noticed when the child was two years old; was incompletely removed; relapsed from the end of the optic nerve left behind; reached, in the course of five years, the size of a small apple in the orbit, and that of a hazel-nut in the skull cavity; was removed; and the child succumbed six days after the operation from purulent meningitis. From the description I received the impression that the growth was a myxo-fibroma, but no cancer. The quantity of arenaceous bodies found in our specimen was so inconsiderable that the name of psammoma, even as an appendix, has no right to enter into its appellation. It was a pure and simple *scirrhous cancer of the outer sheath of the optic nerve.* Considering it as a novelty, at least in the modern ophthalmological literature, I have been so particular in its examination, and have added to the description numerous drawings, all of which have been faithful copies of the specimens, as far as a thinking designer—we mean in contradistinction to sunlight—can execute them.

Does the case under consideration furnish any points for the diagnosis of a *cancer* of the optic nerve? In this regard I would mention two points:—

1. *Severe pain*, which is a noted, and, to a certain degree, a distinctive feature of cancerous growths, was very pronounced in our case. *Graefe* mentions its absence in his cases as indicating benign tumors.

2. *Preservation of the completeness of the visual field* makes it probable that the tumor originates in the outer sheath, which seems to be more apt to produce cancerous growths than the inner sheath, or the filamentous tissue which fills the subvaginal space. In Neumann's and our cases the pseudoplasm encircled the nerve without invading it; in the other cases the nerve, or a part of it, was destroyed either by degeneration or compression. Continued observation is needed to bring more positiveness into this subject.

The *prognosis* in the case under observation is unfavorable on account of the anatomically well-defined cancerous nature of the growth. Yet malignant growths, in a *clinical* view-point, and growths that have the anatomical properties of cancer, are not, in all instances, identical. Is true cancer always malignant? In the initial stage I believe a radical operation may eradicate the evil. Was, in the case under consideration, the disease still

in its innocent youth? and if so, was the tumor radically extirpated? The future will answer both questions. Thus far, eight months after the operation, the patient does well; but the lapse of time since the operation is too short to prove anything. What we can say with certainty is, that *the operation has removed a hideous deformity, relieved excruciating pain, and prolonged life.*

In regard to *operative interference with orbital tumors*, the case under consideration gives a useful, and, to a certain degree, a novel lesson It made the impression upon me that the indications for the removal of orbital growths, without sacrificing the eye, might be more extended than heretofore. In a discussion on the extirpation of orbital tumors, held at the meeting of oculists at Heidelberg, in 1859 (see Transactions of this Meeting, p. 17; Peters, Berlin, 1860), W. BOWMAN advised to attempt, in all cases of circumscribed orbital tumors, first to remove the tumor alone, and only when this proves impossible, to take away the eyeball with the tumor. VON GRAEFE thought "that the method of operation depended on the location of the tumor, which may be either *inside or outside* the funnel-shaped space confined by the recti muscles. In the former case so extensive divisions of muscles and connective tissue would be unavoidable that even a temporary preservation of the eyeball could offer no essential advantages. If, apart from that, the diagnosis is doubtful, and sight lost, the enucleation is indicated. In cavernous tumors the danger of cutting into the growth is increased by the limitation of the space in which the operator has to work."

I quote this statement, since it seems to express the general opinion of the profession on this point, by the mouth of two operators whose authority is unsurpassed. The case under consideration shows, however, that a tumor of considerable size, even when located within the muscular funnel, can be successfully removed without severing any muscle, and with but limited division of connective tissue. I think we may avail ourselves more freely of the elasticity of the muscles and optic nerve than we have hitherto done. If tumors gradually, and the rude process of "gouging" suddenly, displace an eyeball on the edge of its socket without destroying it, sometimes even without permanent damage to sight, why should not we, in surgical operations, push the eyeball aside and forward, as far as the elasticity of the optic

nerve and muscles will admit? And even if the eye be blind, and the growth a cancer, as in our case, the preservation of the eyeball may be of decided advantage. Tumors of the optic nerve are rare, but other tumors in the orbit are frequent enough, that many a bold attempt, if made at an early period, will not only remove the disease, but obviate blindness. With every successful step our courage grows, and new conquests will follow. Concerning orbital growths, my impression is that we should not postpone their extirpation until the eye is threatened or seriously affected; further, that the majority of these growths can and should be removed without sacrificing the globe.

In a *physiological point of view* the case under consideration is of singular interest, being, as it were, a vivisection in the human subject. Before I removed the tumor I had some misgivings as to whether the eyeball would be nourished if all or many posterior ciliary arteries and ciliary nerves were divided. This division seemed unavoidable, since the tumor was supposed to encompass the whole or the greater part of the posterior region of the globe. The result of the operation proved the correctness of this supposition. Intending to spare the muscles of the eye, I thought the anterior ciliary arteries, which are derived from the arteries of the recti muscles, would furnish sufficient nutritive material to prevent the eyeball from sloughing or conspicuous shrinkage. In this supposition, fortunately, I was not deceived. The ulcer of the cornea, which appeared in the first week after the operation, was not the result of want of nutrition, nor a symptom of neuroparalytic ophthalmia, but of exposure of the cornea, an incident I have observed frequently enough. It healed as soon as proper measures were taken for the protection of the cornea. By the operation the inner half of the eyeball had become permanently insensible, the outer half of the cornea was rather dull to the touch, whereas the conjunctiva of the outer scleral part was sensitive enough, though not like that of the other eye. The temporal part of the globe, when struck by foreign bodies, sharp wind, etc., excites movements of the lids, by which dust and other irritating substances are removed, and the cornea is lubricated. This explains why the cornea has not been affected, but remained transparent and bright. If the ulcers which we see in neuro paralytic ophthalmia resulted from the destruction of the

trophic nerves of the cornea, and not from the mechanical injuries which the insensibility of the cornea prevents from being felt, avoided, and removed, the perfectly insensible nasal part of the cornea, in our case, would have sloughed.

Further, it is of interest to note that for some time after the operation *the tension of the eyeball was not diminished.* The absorption of the fluid media in the eye depends on the amount of blood thrown into the globe, and this amount depends on the elasticity of the enveloping coats. As long as there is diminished filling of the globe, the current of arterial blood meets with a diminished resistance, the consequence of which is increased influx, which will last until the former equilibrium between the intra-vascular and extra-vascular pressure, that is, the normal tension of the globe, is re-established. The elasticity of the membranes, thus, is the regulator both of the vascular current and the secretion and absorption of the fluid contents of the eyeball. Our case experimentally shows that the physiological economy of the eye, if I may use this expression, has provisions to counterbalance extraordinary disturbances in its vascular supply.

The most *important results of the operation*, *however*, *were noticed in the retina.* These results, novel and unexpected as they were to me at that time, can be satisfactorily explained by the advanced anatomical knowledge of the circulation in the eye. I take pleasure in mentioning that a classical description of the circulation in the eye has recently been published in *A. Graefe* and *Saemisch's* Cyclopædia of Ophthalmology, by Prof. *Theo. Leber*, of Göttingen, whose investigations on this subject have so materially advanced what men like ZINN, S. TH. SOEMMERING, F. ARNOLD, E. BRÜCKE, CH. ROUGET, E. JAEGER, and others had so admirably begun and prosecuted.

It is highly noteworthy that the *division of the majority of the posterior ciliary arteries occasioned no opacity of the refracting media of the globe.* This is another proof of the vicarious function of the anterior ciliary arteries when the posterior are cut off. The regulating force which re-established and kept up the normal intra-ocular pressure prevented the parts, the integrity of which depends on the uveal tract, from suffering changes of nutrition.

But very differently *did the results of the operation manifest themselves in the retina.* Three days after the operation the re-

tina was seen like a uniformly white, milky surface, no optic disc, no blood-vessels were discernible. On the fourth, two short, dark-red streaks made their appearance. They became thicker and longer, and were successively accompanied by a great many others, until, two weeks later, the complete system of retinal vessels, arteries and veins, was filled with blood again. From what source were they filled? In what way did the blood circulate through them? What were the immediate consequences, and what was the final result of this remarkable phenomenon?

The *first retinal vessels seen after the operation were veins.* They emerged on the area of the optic disc, and, to judge from their subsequent increase and direction, were the upper and lower main branches of the central retinal veins. Only after a greater number of veins had appeared in the centre of the white background, and stretched their course toward the equator bulbi, the arteries were recognized. Both arteries and veins first emerged on or near the optic disc, appeared as short lines, and grew farther toward the periphery every day. This indicates plainly that communications had been established between the retinal and ciliary blood-vessels at the entrance of the optic nerve into the eye. These communications could only be between the choroid and the entrance of the optic nerve, for, first, the ciliary arteries, which directly anastomose with the nerve, were cut; and secondly, the retinal blood-vessels began to be refilled on or near the optic disc. If there existed, in man, communications between the retinal and ciliary vessels in the region of the ora serrata, the existence of which, in the dog, has been experimentally demonstrated by *L. Kugel*,* the retinal vessels would have been injected from the periphery toward the centre.

LEBER says † that many small arteries and veins, and a fine capillary network pass from the edge of the choroid into the intra-ocular end of the optic nerve and the immediately adjacent portion of the retina. Other communications between the choroidal and retinal blood-vessels do not exist, in particular not at the anterior end of the retina, the *ora serrata*. This assertion,

* On Collateral Vascular Currents between the Choroid and Retina. Graefe's Arch., ix., 3, p. 129, etc.

† A. Graefe and Saemisch: Handbuch der Gesammten Augenheilkunde ii., 2, p. 306, etc.

derived from exceedingly careful anatomical investigations, could find no better confirmation than was furnished by our case, and by two others of H. PAGENSTECHER, of which I shall speak hereafter.

The way by which the blood entered into the retinal vessels also is satisfactorily traceable on the basis of LEBER'S researches. The region normally supplied with blood by the posterior ciliary arteries had now to receive its blood chiefly through the anterior ciliary arteries. These, commonly seven in number, perforate the sclerotic not far from the corneal margin, and ramify in the iris and ciliary body, forming arterial circles, out of which ten to twenty *recurrent arteries* arise, which pass between the vessels of the ciliary body directly backward, and anastomose with the short posterior ciliary arteries in the choroid proper. They are very considerable branches, and explain the rapid restoration of the vascular supply in the posterior part of the choroid, on which the transparency of the vitreous and the preservation of the normal intra-ocular pressure depends, as we have seen above.

The manner of the refilling of the retinal vessels in our case may be explained as follows :

At the free edge of the choroid the arterial and venous anastomoses are very numerous. Arteries and capillaries passed from this free edge into the optic papilla and the adjacent part of the retina. There they were collected into small veins, which emptied into the larger veins of the retina. The contraction of the central retinal vein in the cicatrizing stump of the optic nerve closed the natural outlet to the venous blood of the retina. The venous current, therefore, became reversed, which could be without difficulty, the retinal veins having no valves. Thus we saw from day to day the veins extend farther toward the periphery. The more this collateral current developed, the more the direct arterial anastomoses between choroid and retina must have gained strength, until an arterial current of sufficient power had dug its channel between the free edge of the choroid and the optic nerve and adjacent retina to fill the retinal arteries. From the arteries the retinal capillaries were filled, and the retinal tissue was again supplied with nutritive material. The white discoloration disappeared from the periphery toward the centre, exactly in the same way in which we have often observed it when, after em-

bolism of the central retinal artery, anastomoses between the ciliary and retinal arteries have formed. In such cases, as is well known, the retinal tissue clears up entirely and permanently, yet the retina and optic nerve, whose nutrition was interrupted too long, are doomed to atrophy.

In our case there was, however, an essentially different factor additional to the ordinary picture of embolism: *the closure of the central retinal vein*. The blood which had entered the retinal veins through three channels, namely, (1) through the capillaries extending from the free edge of the choroid into the retina, or (2) through the venous anastomoses between the free edge of the choroid and the optic-nerve entrance, and (3) through the capillaries of the retina, after the arterial retinal current was re-established, had either to seek another outlet or stagnate in the retina. The veins were the most dilated in the neighborhood of the optic disc, showing that there the resistance to the current was greatest. Cases of embolism show different conditions: the retinal veins end taperingly on the disc as in our case, but thence their dilatation toward the periphery increases only very gradually, and reaches its maximum at a considerable distance from the disc, whereas, in our case (see Fig. II., Tab. IX.), the dilatation increased rapidly, and in such a degree that even at the margin of the disc the varicose swelling of the veins was well marked. These conditions may be explained as follows: In embolism the end of the central retinal vein is free, and there is no obstacle to the outflow of the blood contained in the veins. A partial contraction of the larger retinal veins, to which a certain degree of elasticity may be ascribed as far as they have muscular coats, forces their contents into the orbital veins on the one side, and forms an obstacle to the centripetal current of the blood contained in the smaller veins and the capillaries.

A greater part than the contractility of the larger veins, the *intra-ocular pressure* seems to play in the production of the described phenomena. The intra-vascular pressure, in general, is greatest at the origin of the aorta, and diminishes gradually in the direction of the current of the blood, becoming lowest at the end of the vena cava into the heart. In the eye the blood-pressure is greatest at the entrance of the central retinal artery, and least at the exit of the central retinal vein. The intra-ocular

pressure must be equal to the intra-vascular pressure at the end of the retinal vein. Were it greater, it would compress the end of the vein and stow the blood at the periphery. Were it less, then the vein would swell as much as the elasticity of its walls admits. The equilibrium between the intra-ocular pressure and the pressure in those portions of the retinal veins which lie nearest to the cribriform lamella, is not constant in all eyes, nor at all times, since in the majority of people we see the end of the vein become thinner—which can only be the effect of compression—when the systole of the heart temporarily increases the intra-ocular pressure by dilatation of the arteries, and then, again, become thicker when, during the diastole of the heart, the arteries contract and the intra-ocular pressure is reduced. These regular oscillations of the intra-ocular pressure above and below the blood-pressure in the intra-ocular ends of the retinal veins, are generally, and certainly with justice, thought to be the cause of the venous pulsation in the eye.

When after embolism of the central retinal artery the intra-vascular pressure, which is imparted to the retinal blood-vessels by the action of the heart, is abolished, the contractility of the walls of the vessels and the intra-ocular pressure are the only motive forces to act on the contents of the vessels. The contractility of the arteries will move the blood into the capillaries and smaller veins ; the contractility of the veins—which is greatest on the papilla, and diminishes toward the periphery—aided by the intra-ocular pressure—which is equal everywhere—will reduce the calibre of the veins, the most at the papilla and successively less toward the periphery, until the stowed-up blood admits of no further compression. THEO. LEBER states (l. c., p. 344) : "that the intra-ocular pressure, in cases of embolism of the central retinal artery, obviates a reflux of blood from the orbit into the veins of the retina, and, consequently, the formation of a hemorrhagic infarctus, which, according to COHNHEIM, depends on a reflux of blood into the veins corresponding to the plugged artery." This explanation can be adopted without hesitation. The intra-ocular pressure being the result of the ciliary blood-vessels and the elasticity of the enveloping coats of the eye, is not appreciably diminished by the absence of so small a blood-vessel as the retinal artery, since we noticed that it remained constant

even after the division of the majority of the posterior ciliary arteries. Since further, as we have seen, the intra-ocular tension is equal to the intra-vascular tension which the retinal vein possesses on the optic disc, in embolism of the central artery, the retinal vein near the cribriform lamella must be completely compressed by the intra-ocular tension which is now greatly in the ascendency, and no reverse current can take place, since the blood-pressure in the orbital portion of the central retinal vein, being less than in its ocular portion, cannot overcome the intra-ocular pressure, which is equal to the blood-pressure in the ends of the ocular veins. In the measure that the communications between the ciliary and retinal arteries develop, the *vis a tergo* in the capillaries and veins becomes stronger, and the pressure in the veins increases, until it ultimately overcomes the intra-ocular pressure and the contractility of the larger veins, and the circulation in the retina is re-established.

In our case the development of arterial communications between the choroid and retina had the effect of pouring greater and greater quantities of blood into the retina, and of filling the capillaries and veins to their utmost capacity, since the main outlet of the venous blood was closed. The way by which the venous blood could leave the retina was the venous and capillary anastomoses between the optic papilla and the adjacent retina on the one hand, and the free edge of the choroid on the other, and thence it went through the vasa vorticosa, at the equator of the globe out of the eye. This seems a long and circuitous road, offering great resistances to the current. The course of the disease also showed that these anastomoses were inadequate. The veins dilated more and more, became varicose (see Fig. II., Tab. IX.), finally burst in many places, and occasioned profuse retinal hemorrhage. Thus we see again a *hemorrhagic infarctus in the retina*, which does not occupy a triangular portion only, as I have observed it in a case described and illustrated in the first number of these Archives, but was very extended. The ultimate result was total atrophy of the retina and partial atrophy of the choroid, metamorphosis of the blood into pigment, and new formation of connective tissue, being the effect of cicatrization after the necrosis of the parts that had suffered the most, namely, the region of the optic disc and its surroundings, and the nasal

half of the fundus oculi. Fig. III., Tab. X., gives a faithful representation of this condition, the last scene in this long play of morbid action.

The nasal half was the seat of more extensive changes than the temporal half, on account of the greater development of the pseudoplasm on the nasal side of the globe, which necessitated the division of all the posterior ciliary arteries and all the ciliary nerves on that side, a fact of which the total anæsthesia of the nasal half of the globe bears evidence. On the temporal side the ciliary nerves and posterior ciliary arteries were partially preserved, for the sensibility in the outer half of the globe was not destroyed, but only diminished. The ultimate slight reduction of the intra-ocular tension has to be taken for the consequence of the atrophy of the retina and choroid supervéning after the hemorrhagic infarctus, as we notice it also in similar alterations which are the result of inflammatory degeneration.

Before concluding, I cannot omit to cite the results of several experiments that have relation to the conditions we observed in this case.

J. COHNHEIM, in his monograph on the embolic processes,* states, as mentioned above, that a venous reflux produces hemorrhagic infarctus. In our case the vein as well as the artery was divided. If there was a venous reflux, it must have taken place through the venous anastomoses between the free edge of the choroid and retina, and this is not at all improbable, since the pressure in the smaller veins is higher than in the larger. A current from the smaller choroidal veins into the larger retinal may, therefore, have occurred, as the intra-ocular pressure, in this instance, was an equal obstacle to both.

Dr. R. BERLIN divided the optic nerve in animals, and noticed no change in the circulation of the retina. The reason of it is, that the central retinal artery in animals enters the optic nerve so close to the sclerotic as easily to escape the instruments.

THEO. LEBER,† who cut the optic nerve of rabbits as near the sclerotic as possible, succeeded in dividing the central retinal artery with it. In such cases he found the central vessels greatly

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* Untersuchungen über die embolischen Processe. Berlin, 1872.

† THEO. LEBER. Graefe-Saemisch's Cyclopædia, vol. ii., part 2, page 345

narrowed; the arteries were seen with difficulty or not at all. The vessels began to refill after several days only, the veins sooner than the arteries.

R. BERLIN,* and THEO. LEBER, divided, in the rabbit and cat, the optic nerve, together with a number of ciliary arteries and nerves in the depth of the orbit, and noticed the above-described changes in the retinal blood-vessels; but, in addition, a very extensive white cloudiness in the retina, which, as LEBER states, was owing to finely granular opacity in the nervous elementary parts, and the presence of granular fat cells in the retina.

In conclusion, I have to quote two cases which have many points in common with ours.

HERMANN PAGENSTECHER describes a case of injury of the optic nerve, with laceration of the central retinal vessels.†

The point of a steel lance had deeply entered the orbit at the upper inner corner. Four days after the injury the patient was seen for the first time. Her eye was completely blind, the pupil wide, immovable. Media clear. Fundus, to the extent of four diameters of the papilla, shining white; two short trunks of blood-vessels were seen. In the following days they became longer, and others appeared. Some of them were interrupted. Congestion of the retina followed. The vessels developed from the centre toward the periphery. Some anastomosed with one another. A small linear hemorrhage was seen near the papilla. All the vessels looked alike, and seemed to be veins. Gradually the fundus cleared up, the papilla was visible, the blood-vessels obliterated, and were converted into white cords, bordered by black pigment. The papilla was shining white. Extensive choroidal atrophy took place.

The diagnosis of laceration of the central retinal vessels was based on this peculiar condition of the background of the eye, which, to the author's knowledge, had never before been mentioned in literature, but he found a brief description of a similar ophthalmoscopic condition, produced by the section of the optic nerve in the orbit, in the clinical journal of the Ophthalmic In-

* R. BERLIN: Ueber Sehnervendurchschneidung. Zehend. Monatsbl., ix., page 278, etc.

† Graefe's Arch., xv., I., page 222, etc.

stitute at Wiesbaden. As the case is of great interest, and very similar to ours, I will transcribe it in full.*

"W. Krebs, æt. twenty-seven, had an orbital tumor extirpated and his optic nerve divided, with the intention to preserve the eyeball, on December 21, 1867. December 25. Ophthalmoscopic condition: Retina yields a white reflex. Here and there some traces of red blood-vessels. Papilla not distinguishable. December 31. Papilla and some vessels visible; adjacent retina still white. January 3, 1868. Papilla dull white, its margin ill-defined, the whole ophthalmoscopic picture indistinct. The vessels and their ramifications can be clearly traced. Retina still white; in the region of the yellow spot apparently detached. January 8. Papilla a reddish disc, from which radiate blood-vessels; veins and arteries not to be distinguished from each other. Retina around disc whitish-gray. In region of yellow spot, deposit of pigment."

This case in many points is a counterpart of ours. Unfortunately the history is so incomplete. It is not said what kind of a tumor was removed, nor how, nor in what condition the eye had been previous to the operation, nor what had become of it later. The sentence, "Optic nerve divided with the intention to preserve the eyeball," is apt to leave some doubt as to its permanent preservation.

Only lately, when perusing the incident literature, I came across this case. Before, I was not aware that the optic nerve had ever been cut, and the eyeball preserved, in removing an orbital growth; but as there is nothing new under the sun, I am sure that by more extensive literary research some other similar cases will be unearthed.

Though there are statements in this paper that I did not learn from others, I may, in concluding it, be allowed to repeat the words of James Hinton in the preface of his Treatise on Aural Surgery, namely, "Nothing is claimed as original." I repeat these words not so much out of modesty, but for the sake of safety from falling into controversies about priority.

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* Hermann Pagenstecher. Graefe's Arch., xv., 1, page 235.

Explanation of the Colored Plates.—Tab. IX and Tab. X.

Fig. I., Tab. IX.—*Represents the ophthalmoscopic appearance of the fundus before the removal of the tumor: Neuritis optica descendens.*

The optic disc swollen with abrupt borders, which only slightly extend beyond the margin of the disc.

Fig. II., Tab. IX.—*Appearance of the fundus three weeks after the removal of the tumor: Excessive venous hyperæmia of the retina, with milky opacity of the posterior portion of the retina.*

A week after the time to which this picture refers, the varicose veins burst, and gave rise to extensive retinal hemorrhage, which gradually became absorbed or metamorphosed into black pigment.

Fig. III., Tab. X.—*Appearance of the fundus seven months after the removal of the tumor.*

The region of the optic disc and its vicinity are covered with an irregular network of connective tissue. The retinal vessels are transformed into white fibrous cords. Large accumulations of pigment (on the nasal and inferior sides of the od) and extensive yellowish-white spots, where the sclerotic is denuded, indicate the places of former hemorrhage. The retina and a part of the choroid appear atrophied. The black parallel lines below the optic disc remain unexplained.

Explanation of the Figures on Plates XI and XII.

Fig. 1. × 1. *The tumor seen from its basis.*
a, surface which was in connection with the sclerotic.
on, optic nerve.

Fig. 2. × 1. *Lateral view of the tumor.*
a, its basis.
c, its apex.
b, connective-tissue covering it.

Fig. 3. × 1. *Longitudinal section through the tumor* (*t*) and the optic nerve (*on*).
b, connective-tissue cover.

f, } outer sheath of optic nerve on nasal side, split into
g, } fibres forming the origin of the stroma of the tumor.
i, inner sheath of optic nerve.
ou, outer sheath on temporal side.
on, optic nerve, compressed at *g*.
s, subvaginal space.

FIG. 4. × 200. *Section through the interior of the tumor.*
aa_1, primary,
bb_1, secondary,
c, tertiary lobes, or alveoli of tumor.
a_1, b_1, *d*, *e*, connective-tissue stroma of the pseudoplasm.

FIG. 5. × 700. *Section through centre of tumor*, showing the connective-tissue elements of the stroma (*aa*) and the epithelial cells (*ee*) filling the alveoli. At bb_1 the apparent formation of new alveoli.

FIG. 6. × 700. Centre of tumor. Stroma and alveoli as before.
bc, formation of new alveoli farther advanced.

FIG. 7. × 800. *Epithelial cells from the interior of an alveolus.*

FIG. 8α. × 700, } *Corpora arenacea.*
FIG. 8β. × 500. }

FIG. 8γ. × 500. Arenoid body standing on edge.

FIG. 8δ. } × 700. Probable transformation of epithelial nests into arenoid
FIG. 8ε. } bodies.
c, centre containing one or several cell-like corpuscles.
a, concentric layers filling the whole space between centre and peripheric ring.
b, concentric layers around central corpuscles.
d, dark, coarsely granular zone.
p, bright peripheric ring of connective-tissue fibres.
f, connective tissue in which the arenoid corpuscles are embedded.

FIG. 9. × 500. *Colloid transformation of stroma of tumor*, *aa* accumulated in round clusters, *b* in winding tracts.
ef, endothelial and fibrous coats of a vessel.
c, artificial empty spaces between stroma and epithelium.

FIG. 10. × 600. *Transverse section of optic nerve and adjacent part of tumor.*
i, inner sheath of optic nerve.
p, perineurium internum.
vv, } subvaginal space.
f, } outer sheath giving off.

gg_1, branches which form the stroma of the pseudoplasm.

FIG. 11. × 700. *Longitudinal section through optic nerve.*

aa, interstitial connective tissue (perineurium internum).
nn, nervous fibre-bundles, infiltrated with lymphoid cells.
s, transverse section of nervous fibre-bundle, infiltrated with lymphoid cells.
v, capillary blood-vessel.

NOTE.—The figures illustrating the foregoing paper have been drawn in part by myself, in part—the better part, indeed—under my supervision, by Dr. C. Heitzmann.

H. KNAPP.

CORNEAL TUMOR WITH MULTIPLE CUTANEOUS TUMORS OF THE SAME STRUCTURE (FIBROMA LIPOMATODES).*

By Dr. J. HIRSCHBERG,

Lecturer on Opthalmology in the University of Berlin.

(Translated by R. Gebser, M.D., of New York.)

(With colored plate, Tab. A.)

Gentlemen: In the year 1867, Prof. von Graefe presented to this Society † a young man with a corneal tumor and multiple formation of tumors in the skin. As I then had the opportunity of observing the case more closely, and as I was obliged afterwards to enucleate the same eye, on account of a relapse of this corneal tumor, I wish to present to you the patient, demonstrate the specimen, and give you a short history of the case.

On April 14th, a certain Mr. Jacob D., now thirty years old, a resident of Schwetz, came to my clinic. When he was eight years of age several tumors, protruding from the surface of his body, were perceived, which increased gradually in number and size. The patient does not know whether any of them have disappeared. In 1867 Prof. von Graefe found the following condition: "The surface of the patient's body was covered with a number of small tumors (mollusca). The smaller ones formed reddish-brown protuberances, flat and lentil-shaped, and measuring a few mm. in width. The larger ones measured from 8–10–12 mm. and upwards, and were dark-brown, transparent at their centre, soft in consistency, coalesced in the bends of the knees, forming several peculiar growths of about the size of an inch."

If you examine the patient to-day you will find the skin disease unchanged in its character, but more extensive. This will

* Nach einem Vortrag in der Berliner mediz. Gesellschaft, April 23, 1874.

† Verhandlungen d. Berl. med. Gesellsch. Sitzung v. 5 July, 1867.

be more apparent if you compare the picture of the left popliteal region of the patient, published by Prof. Virchow in 1871, in vol. 52 of his Archives, with the drawing of the same region (Fig. 1) made to-day by my friend, Dr. Karpinski, or, better still, with the original subject himself. The patient has dark hair, a dark-brown iris, and a sallow skin. The face and neck are free from tumors, as also are the back and the abdomen. On the nape of the neck several brownish papulæ of 3 4 mm. in diameter are seen. On the thorax half a dozen of the same kind, which are much scratched. Very striking is the change on the region of the elbows, the neighborhood of the arms, the thighs, and the popliteal spaces. Over the posterior portion of the right elbow-joint there is found a patch about 9 cm. long and 3,5 cm. broad. It consists of brownish-violet or brownish, old, flat protuberances of the skin, which are pretty small and disseminated at the edge, but become larger toward the centre (from 8–10 mm. in diameter and more), more protruding and coalescing, so that they form a coherent band, three cm. long and one cm. broad, which is covered with a thick layer of epithelium. On the anterior aspect of the elbow-joint there is a circle of small, brownish cicatricial spots, measuring 3–4 mm. On the left elbow the change is the same, only less marked. At the inner side of both thighs there are again very large plaques (9 cm. long and 7 cm. broad). At their edges the single spots are small; at their centres larger, brownish-violet in color, and slightly prominent, closely crowding together, but not coalescing. The traces of a spontaneous retrogradation of the nodules is very interesting in this place. Some of the latter are only prominent and brownish in a small peripheric zone, but consist of whitish cicatricial tissue, and are depressed in their central portions. The cicatrization seems to be due more to parenchymatous atrophy and absorption than to ulceration of the surface, as the growth of hair on these cicatricial spots had not suffered. Flat, brown foci, as large as a hand, are to be seen on the buttocks where these touch each other, and in the groins. From here single spots extend down to the popliteal regions, where the affection reaches its greatest extent. Here the single nodes are pretty large, convex, and thickly spread. On the left side in the centre of the focus a ridge of the width of a finger and of the length of half a finger was formed, mainly over the median

flexor tendon, and on the right side two cords of the same kind,* one on the lateral, the other on the medial flexor tendon. In these places the same partial atrophy is to be seen. All nodes and ridges are situated entirely in the cutis, and can be easily moved together with the skin over the underlying parts.

If we consider the topography of the main patches, we observe, first, the symmetrical arrangement over both sides, and then the predilection for places where two parts apply continually or very frequently, or where the skin is often exposed to excessive tension by the movements of the joints.*

The pathological explanation of the affection of the skin is difficult without an anatomical examination. Fortunately such an examination has been made some time ago, as Prof. Virchow (in his Archives, vol. 52, 1871)† has described the case as xanthelasma multiplex or, better, fibroma lipomatodes. He found in removed pieces of skin that the nodules were thoroughly filled with fat globules in the centre, but that their peripheral parts consisted mainly of elements of proliferating connective tissue. The nature of the growth lies between adipose and connective tissue. The peculiar color depends partially from the pigmentation of the deepest cellular layer of the rete Malpighii, and partially from the pathological tissue of the neoplasm, which is shining through.‡

The same patient possesses likewise a remarkable growth on the right eye. Naturally the question arises as to whether there is a connection between the cutaneous tumors and the corneal growth, or at least an analogy between them. Therefore, I shall first describe the affection of the eye.

About ten years ago a tumor, which Mr. D. had never noticed, was detected by a physician on the right eye. In 1865 Prof. von

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* Disease of the interior organs cannot be found; no swelling of the lymphatic glands.

† Compare the notes of Leber, in the same volume.

‡ I did not omit to remove a small piece of skin from the left popliteal space on the junction of the healthy and diseased tissue. Beneath a powerful epidermis and a thick rete Malpighii, whose deepest layer contains well-pigmented cells, there appear well-developed single papillæ. The upper layer of the true derma contains oval and stellate pigment cells and numerous colorless cells between the fibrillæ, which appear more densely packed in the deeper parts, but preserve still the structure of connective tissue. The nodule is probably of a later date, and consequently the fatty degeneration not developed.

Graefe performed the first operation, the affected eye being then able to see pretty well; in 1867 the operation was repeated, when the sight was already considerably diminished. At that time a dirty-yellowish tumor, projecting several lines, had formed on the right cornea, and, covering the greatest part of the latter, had rendered sight nearly impossible. The tumor was sliced off at its base. At the same time yellow spots were seen on the cornea of the left eye, which Von Graefe had noticed in their first beginning, eighteen months previously, and believed to be the commencement of an analogous corneal tumor.

It may be aded, that a few weeks after the second operation the tumor relapsed on the right eye, destroying the function of the organ entirely. During the last few days it had increased in size, and caused the upper lid to bulge so that the patient was considerably annoyed, and unable to attend to his business; he says that the spots on his left eye are more distinct since the past year, and that he does not see as well at a distance as before.

At the time the patient came under my care the right eyeball was extended in the direction of the optical axis, but easily movable; the region of the cornea was occupied by a convex, rugged, yellow tumor, of the size of a walnut. It was about 20 mm. broad, and 15 mm. high; its depth could not be ascertained, as its large base covered the anterior part of the bulbus.

In the apex the tumor was fungus-like and well defined; in its base, however, passed gradually into the cornea. From below a large conjunctival vein spread in several branches over the anterior surface of the tumor. Above the episcleral tissue was thickened, red, and pterygium-like. The left eye reads Sn. 2 at 4″ with — 12 Sn. C at 15′; visual field complete. It showed as eyes with maculæ corneæ usually do, myopic adaptation, with imperfect correction at a distance. In the upper quadrant of the cornea there was and is at present a white-yellowish, non-protruding spot, 2‴ broad and 1‴ high; an adjoining gray zone hides the upper part of a moderately dilated pupil. Besides, there are in the lower quadrant of the cornea several very small yellow spots, surrounded by gray coalescing halves (v. Fig. 2). The eye is free from irritation—its fundus normal.

The upper yellow spot did not grow larger, or at least not prominent in the course of seven years, so that it appears some-

what doubtful if it can be taken for the first beginning of the growths to those observed on the right eye about ten years ago, and which in the course of one and a half years had spread over a considerable part of the cornea, unless we assume that in the left eye the tendency to proliferation was reduced to a minimum. This, however, would only constitute a circumlocution. The examination of the left eye, with the corneal microscope, showed that the white yellowish spot was somewhat deeply situated under the surface of the cornea. It consisted of minute round spots (coalescing), and was intersected by a net-work of capillary vessels, which probably changed into the macroscopically visible conjunctival veins.

There was no doubt that the tumor of the blind right eye should be removed by operation. On April 15th, after division of the canthus externus, I performed the operation of enucleation of the eyeball, and cautiously cut the nerve as far back as possible. The healing took place in a normal manner. The anatomical examination of the relapsed tumor, made in the year 1867 by Leber, had shown that its body consisted partially of little granulation cells, but the greater part mainly of well-developed, large stellate cells, with large nuclei, which would have been considered sarcomatous elements if found in a more voluminous growth, and not accompanied by that general disease. The base of the tumor showed a tissue similar to that of the cornea, but largely infiltrated with nests of fat-globules. "Von Graefe remarked that it hardly could be called a real malignant tumor."

The full length of the enucleated eyeball is 30 mm., its vertical diameter 25 mm., its horizontal diameter 24 mm.; the adhering portion of the optic nerve 8.5 mm. long is entirely normal. The specimen hardened in chromic acid was divided in the horizontal meridian. It shows at once that the growth originated only in the cornea, which, however, had become entirely incorporated in its formation. There is in the inner half only a thin lamella of the cornea remaining, and also a very shallow anterior chamber. On the outer half of the specimen the tumor protrudes into the anterior chamber, and is entirely faced with the anterior part of the iris, thus abolishing the anterior chamber. The globe itself is of regular shape, certainly not much larger than normal, the optical axis from the macula lutea to the supposed posterior sur-

face of the cornea measuring 22 mm. Sclera, uveal tract and retina normal. The iris shows the changes which follow irritation. The pupil is irregular, having the shape of a lengthened triangle, and is covered by a thin membrane, whose anterior surface is attached in its greatest extent to the posterior surface of the neoplasm ; the ciliary body is thickened, the lens slightly cloudy ? corpus vitreum clear.

The neoplasm on its cut surface (Fig. 3) measured from its anterior to its posterior point 7–8 mm., from right to left 17 mm. ; toward the mediate line it extended more than 5 mm. over the surface of the sclera, which membrane is of the usual thickness. The cut surface of the tumor is yellowish-gray, and shows a great many smaller and broader stellate and net-like patches of a white-yellowish color ; it is rather soft, and only the upper layer is somewhat harder, resp. hardened. The microscopical examination of the neoplasm presents a rich, cellular tissue, with cells of different sizes and forms, and a distinct fibrous intercellular substance ; the whole growth is covered by a thin, fibrous layer. It is difficult to decide whether it should be called granular connective tissue or sarcoma.

The diffuse fatty infiltration of the cellular elements is very remarkable ; it commences at the anterior surface, and diminishing gradually it can be traced in the form of nests and striæ through the whole thickness of the neoplasm. The spindle-shaped contours of the cells are well preserved ; the infiltrated fat forming large granules, just like xanthelasma, as described by Waldeyer. In the whitish striæ and spots the greater part of the cells are degenerated into round and enlarged fat globules. The attachment of the tumor to the iris is represented by a parallel fibrous layer with many cells. Where the anterior chamber is preserved, the glass-like membrana Descemetii can be seen, and near to it a translucent layer of slit-shaped lacunæ filled with fat granules.

Special attention should be given to the resemblance of the cutis and the corneal neoplasm, which seems the more interesting in consequence of the microscopic difference. It would be an admissible hypothesis that the cause of a similar proliferation with fatty degeneration of the cell elements should be found in the cutaneous cover of the bulbus in the same way as it pre-existed in the numerous tumors of the skin. Whether the cause of this neoplasm was congenital or not cannot be ascertained at present.

Tab. V

HOW THE MOVEMENTS OF THE EYES MAY BE UTILIZED IN DIAGNOSTICATING ONE-SIDED BLINDNESS.

By H. KNAPP.

THE numerous methods of discovering real or simulated one-sided blindness, published thus far, are based upon the perception of double-images produced by prisms, or upon recognition of objects seen through a stereoscope, about which the patient on trial can give no satisfactory account.

It seems that too little attention has been called to the fact that the *position and movements of both eyes, in monocular and binocular vision*, can be utilized for this purpose. Let the binocular fixation first be tested. If this presents the normal common field of fixation, it is quite improbable that one eye is blind. The eye represented as blind may now be alternately covered and uncovered, while the object of fixation is made to approach or recede before the eye.

If the eye alleged to be blind promptly and accurately fastens itself upon the object of fixation, the latter being outside the limits of the muscular mesoropter, then the eye is not blind, since it participates in the act of binocular vision. In confirmation of this, place, as WELZ does, a prism of about 12°, with the base turned outward, before the pretendedly blind eye, and notice whether this eye moves toward the nose. In this case we may be certain that the binocular images produced by the prism are fused by the adduction of one eye. If, then, the prism is quickly withdrawn, and the eye turns toward the temple in order to effect the fusion of the double-images, then the evidence is doubly convincing. In squinting people only, this method is unavailable.

As an illustration, I will give the details of a case which is interesting also in other respects.

A very excitable young lady, æt. 18, living in New York, was affected three years ago with violent spasms in the eyelids, intense photo-

phobia, and pretended weakness of sight in both eyes. On careful investigation I found both eyes in perfectly normal condition, but besides the stated photophobia and blepharo-spasm she had also spasm of accommodation and concentric limitation of the field of vision. She read the finest print near by, but could distinctly see at a distance, only by means of powerful concave glasses ($\frac{1}{5}$), with which, however, she could not see close by. She therefore had the well-known picture of retinal anæsthesia (of A. von Graefe), or retinal hyperæsthesia (of Steffan), with concentric contraction of the field of vision. The contraction of the visual field varied greatly, while the photophobia and blepharo-spasm soon ceased to be troublesome. The field of vision in the right eye was permanently narrowed down to the perception of the *point of fixation*, whereas that of the other was only at times strongly contracted. After this affection had lasted about a year and a half, the patient announced that she could no longer see with her right eye. The pupil of this eye promptly responded to changes of light. Nothing abnormal showed itself in the interior of the eye, the papilla, in particular, had the usual pink color, its arteries were of medium thickness, and pulsated on pressure. My prognosis, consequently, was favorable.

As this condition of things, however, lasted some two months, the suspicion crossed my mind that the young lady was simulating. I placed in a stereoscope a vertical line before the right eye, and a horizontal line before the other. The patient said she saw nothing but a horizontal line; but she had the habit of rapidly closing the right eye, whenever I made any experiments. Yet, when I prevented her from doing this, I could obtain no satisfactory results with the stereoscope. I then made her look at the tip of my finger, with both eyes kept open. Her binocular fixation was correct and steady from $2\frac{1}{2}''$ to ∞. I then closed the left (healthy) eye. She announced she could see nothing, and did not follow any object shown her. I then covered the right (professedly blind) eye, and found, on removing my hand, that it was directed exactly at the point of fixation, even when this was moved from two feet to infinite distance. *The nearer the object of fixation was, the more the eye, behind the concealing hand, was turned outward; but when I took my hand away, it at once fastened itself upon the point of fixation.* When I held prisms before the right or left eye in different directions, and caused her to look at the light of a candle, she never would speak of seeing two lights. *When I held a prism of* 12°, *with the base turned outward, before the right (professedly blind) eye, and made her look at the candle flame, the right eye showed a perceptible inward movement, and when I took the prism away, and bade the patient look fixedly at the light, the right eye*

turned outward and resumed its former correct position. I next had the patient read fine print, and held a prism of 7°, with its base turned downward, in turn before the left and the right eye. In either case she at once or very soon was unable to continue the reading.

Pressure on different parts of the sclerotic produced vivid phosphenes in the left eye, but none at all in the right. The pupils in both eyes always reacted quickly and fully.

This affection has lasted, at the time I am writing, about three years, without any improvement. The young lady is vigorous, mentally and physically well developed, and looks healthy. She suffers from dysmenorrhea.

The alleged blindness in the right eye has lasted about eighteen months uninterruptedly. Is she really blind in this eye, or is she deceiving? Simulation in this case could only be the result of a freak. Can the phenomena be explained by assuming that the visual impressions made on the right eye alone are not perceived, whereas they co-operate in binocular vision. The existence of binocular vision is unquestionably proved by the accurate binocular fixation, by the immediate return of the eye to the correct direction of fixation when it had been covered, its fellow looking at a point of fixation situate this side of the muscular mesoropter, and by the compensating adduction or abduction when prisms were held horizontally before the eye and then removed. That double-images can exist without the patient being conscious of them, is proved by the following well-known experiment: If the finger or a slender stick be held about half a foot before the nose, while at the same time one looks at some point beyond, we shall find that many persons do not distinguish the double images of the finger or stick, or, at least, can only do so after much practice. Such double-images as these, and many others, are constantly in existence; they do not, however, disturb us, because we have become so perfectly familiarized with them. The strongest proof in favor of the patient's simulation was the reading test. Here the double-images worked in such a disturbing manner that reading became impossible. She could not explain this disturbance clearly; she said the letters disappeared gradually or entirely, which was evidently the result of the double-images, the latter producing fluctuations of accommodation and fixation.

Here the fusion of the double-images, which took place in some of the former tests, was not possible.

From the fact that in retinal anæsthesia phosphenes can be produced also in those parts of the retina which correspond to the defects in the field of vision, VON GRAEFE (Zeh. Klin. Mon., 1865, pp. 62, 63) draws the conclusion which is adopted by SCHWEIGGER (Lehrbuch der Aug., 2te Aufl., p. 548) and HIRSCHLER (Wiener Med. Wochenschr., 1874, p. 906), that the terminal elements of the retina are paralyzed, but the conducting power of the nerve-fibres is preserved.

I can confirm the fact, but consider the conclusion erroneous. Pressure on the posterior part of the sclerotic always produces circular figures, and is to be accounted for by an excitement of the rods and cones, but not as an excitement of the nervous fibres under pressure. In the latter case those nerve-fibres which pass from the periphery inwardly over the spot pressed upon, would also be excited. Their excitation, according to the well-known law, that the irritation of any point in the course of a nerve is always referred to the periphery, must produce a rectilinear, but no crescentic or circular figure. In the patient's left eye her central acuity of vision generally was not below a third, and her field of vision invariably greatly contracted. The phosphenes in this were perceived promptly and distinctly, both over the anæsthetic and the sensitive portions of the retina. Although the prompt and correct statements which the patient made about this eye testified to her good-will and sincerity, still I cannot acquit her of simulation. The reading-test by prisms, as mentioned above, the correct binocular fixation persisted in, even when prisms were held horizontally before her eye, demonstrated unmistakably the participation of the professedly blind eye in the binocular vision. That the retinal image in the allegedly blind eye was perceived as such, was proved by the disturbance produced by prisms in the reading-test. The patient is a young lady fond of society and amusements, who does everything in such a way that no one would ever suspect she was blind in one eye and had such a contraction of the visual field in the other as to leave her hardly more space than the point of fixation. While attending her in April, 1875, for a furuncular otitis, and without questioning her about her eyes, I let her follow my hand, whilst I alternately covered

either eye; she would at times correctly follow the movements of the hand with the allegedly blind eye, even when the other was covered, which probably had escaped her observation. Monocular central fixation, therefore, was present. When I repeated the experiment with vertical and horizontal lines in the stereoscope, watching closely that she kept both eyes open, her statements concerning the figures seen with the right only were correct three times out of eight. WARLOMONT'S test of producing double-images, by displacing the eye with the finger, failed with the patient; but she was trapped by the ingenious test devised by CUIGNET. When I held a rod, about one centimetre in thickness, before the patient's face in such a manner that it came exactly in a line between the left (healthy) eye and the printed page of a book, the patient read the print without difficulty and without moving her head or the book. If her other eye had been blind, she would have been prevented from reading, because the rod concealed a part of the page from the left eye.

From this case it is evident that it is not always easy to detect the simulation of one-sided blindness, and for this reason a new method of testing it may not be unwelcome, especially when it can be conducted without instruments, and has the advantage of simplicity, requiring only the examination of the movements of the eye.

The method of WELZ is described in the *Compte-Rendu of the Congrès International d'Ophthalmologie de Paris, of* 1867 (p. 123), and is quoted by STELLWAG (treatise, 4th edition, p. 214), who mentions also the well-known staring look and the unsteady movements of the amaurotic eye.

ON THE DETERMINATION OF THE FIELD OF VISION.*

By Dr. J. HIRSCHBERG, of Berlin.

(Translated from the German by H. Knapp.)

(With 3 Woodcuts.)

A. von Graefe, who was the first to appreciate the importance of the determination of the visual field in the diagnosis and treatment of ophthalmic disease, used for this purpose, as is well known, a large blackboard, the centre of which was looked at from a rectangular distance of about 12 feet. The examiner passed a movable object, for instance a white ball at the end of a black rod, in every direction, from the periphery toward the centre, thus finding and mapping out the limits of the field of vision. Some years ago Prof. Förster gave a new impulse to this examination by the invention of his *perimeter*. This instrument, as is well known, consists mainly of a graduated semi-circle which, by revolving on its apex (pole), can assume any inclination toward the horizon. The eye under examination is placed fixedly in its centre of curvature, and looks at a point in the pole of the semi-circle. The limits of the visual field are determined by a small square plate, which slides along the inner side of the semi-circle. The introduction of this instrument into general practice leads, here and there, to the erroneous opinion *that the determination on the blackboard is less accurate in principle*. This, however, is not the case. It is true that the visual field, being the projection, through the nodal point of the eye, of the expanse of the retina as far as it perceives the light, represents an angular magnitude, namely, a portion of a sphere, the radius of which may be arbitrarily chosen, and which bears a constant relation of position and extent to the whole sphere. It is best determined by all the polar angles, the apex of which is in the nodal

* This paper was read, in substance, before the Physiological Society, in Berlin.

point of the eye (centre of the sphere of the visual field), and the crura of which touch, in any given meridian, the limits of the surface of that portion of the sphere. The measurement with the perimeter furnishes *these angles directly*. The measurement on the blackboard, on the other hand, furnishes *linear magnitudes, which are accurately proportionate to these angles.* If β, being, for instance, $= 40°$ vertically above the line of fixation, be determined by perimetry, the corresponding linear magnitude found by measurement on the blackboard will be

$$P = e \text{ tang. } \beta,$$

e being the distance of the nodal point of the eye from the centre of the blackboard (see Fig. 2).

The only difficulty with the blackboard lies in the fact that the visual field of a normal eye reaches about 90° outward. Since tang. $90° = \infty$, the extent of the blackboard in this direction necessarily falls short. For many cases of contracted field of vision, however, or of circumscribed defects, the blackboard is not only available, but very convenient. Care has to be taken, as in the use of the perimeter, that the eye under examination does not move during the experiment. Furthermore, we must know beforehand the angles which correspond to the linear magnitudes found by the examination.

In the following table the first column refers to $e = 10''$, the third to $e = 12''$. By $e = 6''$, the errors of observation would be too great.

P″	β°	P″	P″	β°	P″
0,875	5	1,050	10,000	45	12,000
1,763	10	2,116	11,918	50	14,306
2,679	15	3,217	14,281	55	17,137
3,640	20	4,368	17,321	60	20,785
4,663	25	5,596	21,445	65	25,744
5,774	30	6,938	27,475	70	32,970
7,002	35	8,402	37,321	75	44,785
8,391	40	10,069	56,713	80	68,056

A square-shaped blackboard of two feet in length, or four square feet in surface—such as I use—suffices for $e = 22''$, *i.e.*, to

the 45th degree. It may be graduated according to Fig. 1. One millimeter of the figure represents one inch on the blackboard. The constant increase by 10° of angular magnitude corresponds to linear segments which steadily become larger towards the periphery, since the tangent of a growing angle grows more rapidly than the angle itself.

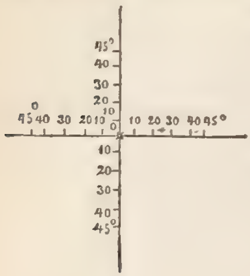

Fig. 1.

The determination of the visual field may be done quite exhaustively with the perimeter. If we use the perimeter of SCHERK,* which consists of a hollow hemisphere of sheet-iron, the inside of which is marked with parallel circles from 10° to 10°, and by meridians from 30° to 30°, their centre being the immovable eye, and their pole the fixed object of fixation; and if we note with chalk the limits of the visual field, as tested, then the question arises, how, for the purpose of recording our observations, we can best transfer this spherical figure to the plane of the paper. Ordinarily the meridians are represented by straight lines radiating, under the corresponding angles, from the point of fixation as their centre, whereas the parallels are represented by concentric circles around the same point of fixation. Their radii increase in a simple ratio to their distance from the centre, in such a way that the length of the radius of the parallel of 10° of polar distance is one-half of that of 20°, one-third of that of 30°, one-sixth of that of 60°, etc. We evidently imagine the plane of the drawing (the paper), whatever degree of foreshortening we may choose, as being perpendicular to the visual line in the point of fixation, as in Fig. 2, in which A represents the nodal point of the eye, B the point of fixation; therefore A B the radius *c* of the semi-circle C B D. But it is evident, at the first glance, that equal arcs, projected in the usual way upon the tangent line E F, do not give equal rectilinear magnitudes.† If we transfer the visual field from

* This instrument, when placed opposite a high, lightsome window, admits of a sufficient intensity of illumination, and renders the examination very convenient.

† The arc B K gives B G, the arc L M = B K gives H I; B G being considerably larger than H I. Let $c\,d$ be the projection of a small arc $a\,b$, then we obtain $c\,d = a\,b.$ cos. $(a\,b, c\,d) = a\,b$ cos. $a\,m\,a$, or generalized (1) $dp = d\,b$ cos. β. if $d\,b$ denotes a small arc, β, its angle of inclination toward the polar tangent, and dp its rectangular projection.

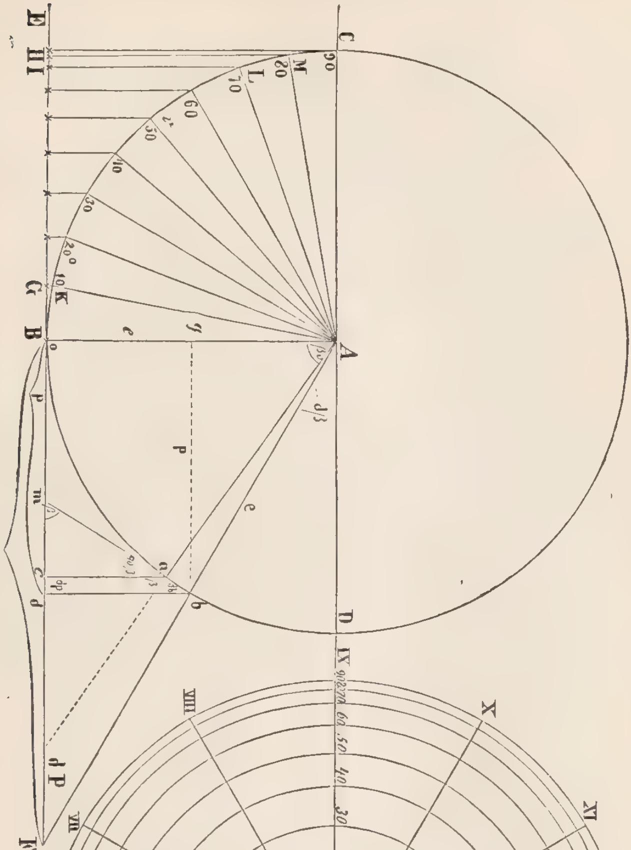

Fig. 2.

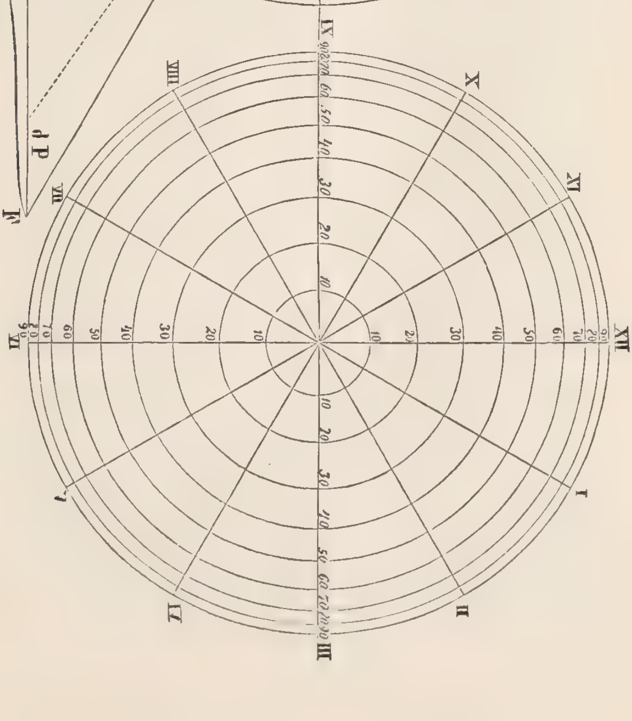

Fig. 3.

the spherical surface to the plane of the paper by rectangular projection, *the radii of the parallels must be proportionate, not to the numbers of the degrees, but to their sinuses*,* as is illustrated in Fig. 3.

I have here restricted myself to 12 meridians, respectively 12 radii, as in Scherk's perimeter, the end-points of which are marked with Roman numbers, in the same manner and succession as the numbers of a clock. This is very convenient for keeping records. I note, for instance, of a patient suffering from retinitis dextra :

December 23, 1874. F R 55, 80, 85, 85, 70, 62,
65, 60, 55, 60, 45, 50.

In this way the two radii, which severally form a straight line, are placed the one above the other, so that by addition the total extent of the visual field in each of the six directions may be ascertained. In the same easy way a circumscribed defect in the visual field may be noted down, if we do not deviate from the once chosen order of the meridians, except when the defect is very small, or situated between two of the twelve meridians. In a patient suffering from the ordinary *scotoma centrale nervosum*, I noted :

F L 56, 65, 45, 43, 56, 65,
60, 90, 90, 70, 55, 58.
Scot. c. 10, 8, 3, 6, 7, 8,
9, 20, 20, 20, 20, 20.

Every one who examines many patients will soon find it more

Since in the quadrant from B to D, as is easily understood, β regularly augments from 0° to 90°, and, accordingly, cos. β regularly diminishes from 1 to 0; the projection of the same portion of the quadrant, for instance, of the arc of 1°, must regularly diminish from the point of fixation toward the limit of the visual field. From 1 is deduced $dp = \cos.\ \beta.\ d\beta$ as follows: In analytical geometry angles are not measured by degrees, but by the respective arcs of the radius $= 1$. Each element of a curve db, *per definitionem*, is to its central angle as the radius e is to 1. Therefore, in our case, $\frac{db = e}{d\beta = 1}$; or, $db = e\,d\beta$, which, inserted into equation 1, gives $dp = e \cos.\ \beta\, d\beta$. The whole projection (for instance, Bd), therefore, is $p = e \sin.\ \beta$, as is evident at once, if we construct $bg \pm Bd$.

* This has been pointed out also by SNELLEN and LANDOLT in Graefe-Saemisch's Handbuch. See also DOR, Arch. f. Ophth. xix., 3, p. 319, and MAZZELOW, Annal. d'Ocul. lxxiii., p. 130.

convenient to keep numerical records instead of diagrams. For ordinary cases they may be used exclusively, and in cases the visual field of which has once been mapped out by a drawing, subsequent observations may be recorded in the numerical way: In this diagram radius III of the right eye corresponds, of course, to radius IX of the left.

In whatever way we may note the results of the measurements of the visual field, we must be aware of the difference between the *central* (radial) *projection* $B\ F$ (see Fig. 2), and the *orthographic* (rectangular) *projection* $B\ d$ of the same arc $B\ b$ of β degrees upon the same tangent B E. B F is proportionate to tangent β, and $B\ d$ is proportionate to sin. β. The radial projection is obtained directly by the measurements on the blackboard ("campimetry"), on account of which the form of the diagram represented in Fig. 1 is the most natural; in recording the measurements with the perimeter (perimetry), the rectangular projection is to be preferred. Considering the hemianopsiæ, it is appropriate to make the yellow spot the centre of the visual field.

ON THE DETERMINATION OF THE FIELD OF FIXATION.

By Dr. J. HIRSCHBERG, of Berlin.

(Translated by H. Knapp.)

(According to a paper read before the Physiological Society of Berlin.)

THE same elementary principles that govern the determination of the monocular field of vision hold good for a simple representation of the conditions of the binocular *field of fixation* (*Blickfeld*). They furnish a sure basis of comparing, in a simple and objective manner, the motility of the eyes of different persons, as well as the motility of the eyes of the same person at different periods, for instance, before and after the operation of strabismus, provided that both eyes have good sight, and binocular vision be either preserved or have been reëstablished. If we aim at elevating the treatment of squint over the mere cosmetic standard of removing the deformity to the dignity of a radical cure, physiological principles must guide us in determining accurately the correction of the diplopia by operation, the choice of glasses, and ocular gymnastics. For that purpose it is necessary to know the mechanical conditions of the position of the eyes relative to every point in the field of fixation, and we must be able conveniently to survey these conditions. A new measuring instrument not being required, a few simple determinations made in the ordinary examining room suffice to give quite satisfactory results.*

* Similar determinations have already been made for physiological and pathological purposes (see HELMHOLTZ, Phys. Opt., p. 27, and A. VON GRAEFE, Arch. f. Ophthal., I., 1, p. 13), but have not yet found their way into general practice.

The field of fixation, A S B, common to a pair of normal eyes, R and L, is a part of the surface of a sphere, the centre of which, M, bisects the basal line (*i.e.*, the union between the points of rotation, d_1 and d_2) and the radius of which, M S, is arbitrary (see Fig. 1).

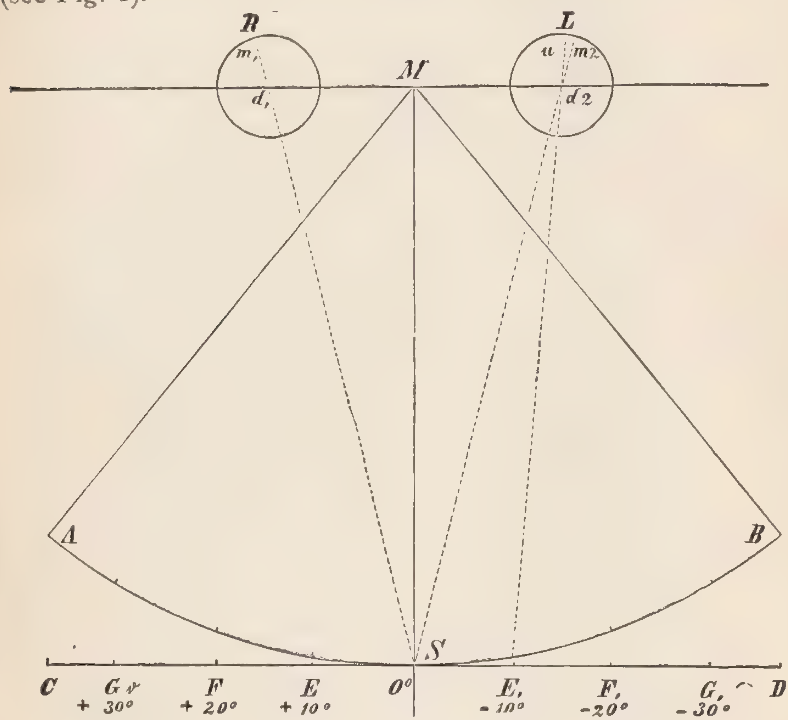

Fig. 1.

Let the plane d_1 d_2 S be that of the primary position, consequently horizontal when the position of the head is upright. S is the vertex point (pole) of the common field of fixation. Only that part of the common field of fixation the central angle of which, A M B $\leqq$ 80°,* is, in binocular fixation, ordinarily travelled over by the crossing point of the two lines of fixation.†

* The maximum aperture of the angle of fixation is $2 \times 50° = 100°$ in the horizontal direction, $2 \times 45° = 90°$ in the vertical direction; yet there are eyes, otherwise normal, which in the horizontal direction cannot fix their gaze over more than $2 \times 28° = 56°$.

† In physiological optics three straight lines, almost coinciding, are distinguished :

For that part alone, the law of Listing is valid in its full strength. When extreme lateral and vertical movements, which we seldom execute, are required, they are supplied by rotations of the head, especially in pathological cases. Patients suffering from binocular diplopia are always satisfied when their common field of fixation obtains an aperture of $2 \times 30°$ in which they see single. To attain this object either fully or approximately, we have, before the operation, more accurately to examine the character of the diplopia, at least in some few principal points of the field of fixation. For this purpose the field of fixation, divided into degrees, is projected upon a vertical plain tangent to the vertex of the sphere of the field of fixation. Fig. 1 represents the projection of the primary position upon the floor.

We choose a suitable wall in the examining room, bisect its edge, C D, which cuts the floor, draw from the point of bisection, S, a plumb-line in the plane of the floor, NS=2 meters, and mark upon C D the following longitudes :

$$
\begin{array}{llll}
S\,E = S\,E_1 = 0{,}35 & \text{meter} & \\
S\,F = S\,F_1 = 0{,}73 & \text{``} & \\
S\,G = S\,G_1 = 1{,}15 & \text{``} & \\
S\,H = S\,H_1 = 1{,}68 & \text{``} & (*)
\end{array}
$$

The point S is marked 0°

$$
\begin{array}{lll}
E \text{ with} = 10°, & E_1 \text{ with} & -10° \\
F \quad \text{``} \quad = 20°, & F_1 \quad \text{``} & -20° \\
G \quad \text{``} \quad = 30°, & G_1 \quad \text{``} & -30° \\
H \quad \text{``} \quad = 40°, & H_1 \quad \text{``} & -40°
\end{array}
$$

In the planes of the wall, plumb-lines are drawn from the points S, E, F, G, H, E_1, F_1, G_1 and H_1, and made so conspicuous (by parting strips of paper of 1–2 mm. in breadth on them), that

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1. The line of vision (Sehlinie), passing from the point of fixation (Blickpunkt) to the fovea centralis; 2. The line of fixation (Blicklinie), passing from the point of fixation through the point of rotation of the eye, and 3. The line of sight (Visirlinie), passing from the point of fixation through the centre of the pupil.—TRANSLATOR.

* These numbers are taken from the tables of logarithms, S E=M S tang. $10° = 2 + 0.1763$, etc.

even moderately good eyes can conveniently see them at a distence of 2 meters. In the vertical plane, a longitude S T = 1.16 meter is measured off on the plumb-line (over S) marked 0°, and through the point T a horizontal line is drawn, the end points of which are marked 0° ; 0.73 above it, another horizontal line, with the end points + XX°; the horizontal edge of the wall on the floor receives the mark — XXX°. In this way a kind of a system of co-ordinates is described in the plane tangent to the sphere of the field of fixation. Each point of this plane is unmistakably determined by two angles counted from the centre of the sphere of the field of fixation. This is done in a manner sufficiently accurate and convenient for practical purposes.

Thus we obtain the following 27 principal points of the field of fixation, resp. of its tangent plane :

0° 0; 0°, + 10°; 0°, + 20°; 0° + 30°; 0°, + 40°;
0°, − 10°; 0°, − 20°; 0° − 30°; 0°, − 40°;
+ XX°, 0°; + XX°, + 10°; + XX°, + 20°; + XX°, + 30°; + XX°, + 40°;
+ XX°, − 10°; + XX°, − 20°; + XX°, − 30°; + XX°, − 40°;
− XXX°, 0°; − XXX°, + 10°; − XXX° + 20°; XXX°, + 30°; − XXX°, + 40°
− XXX°, − 10°; − XXX°, − 20°; − XXX°, − 30°; − XXX°, − 40°.

In the majority of cases these points, frequently even a less number, will be sufficient. In prolonged examinations persons soon lose patience, and the distances of the double-images which they indicate, represent nothing more than magnitudes of fatigue. To render the zero point of the vertical divisions suitable enough for all patients, we have to make provision that, the position of the head being vertical, their basal line be about 1.16 meter above the floor. M S is chosen 2 meters in length, for in diplopia those portions of the eyes are of greatest importance which correspond to a moderate distance of objects ; if the radius of the field of fixation is short, the measurements become inaccurate ; if the radius is long, the size of the examining-room is commonly insufficient. To facilitate to the patient the estimation of the distance of the double-images, and to obtain, without any reckoning, at once the angle of vertical and lateral deviations of

the squinting eye, instead of the linear magnitudes of the horizontal and vertical distances of the double-images, the above system of coördinates is here completed up to whole degrees. This can easily be done with a ruler and a pair of compasses, taking into consideration that in a sphere of a radius of 2 meters the following relations exist :

Degree.	Tangens (in meters.)	Degree.	Tangens (in meters.)
0	—	21	2 × 0.3839 = 0.7678
1	2 × 0.0175 = 0.0350	22	2 × 0.4040 = 0.8080
2	2 × 0.0349 = 0.0698	23	2 × 0.4245 = 0.8390
3	2 × 0.0524 = 0.1048	24	2 × 0.4452 = 0.8904
4	2 × 0.0699 = 0.1398	25	2 × 0.4663 = 0.9326
5	2 × 0.0875 = 0.1750	26	2 × 0.4877 = 0.9754
6	2 × 0.1051 = 0.2102	27	2 × 0.5095 = 1.0190
7	2 × 0.1228 = 0.2448	28	2 × 0.5317 = 1.0634
8	2 × 0.1405 = 0.2810	29	2 × 0.5543 = 1.1086
9	2 × 0.1584 = 0.3168	30	2 × 0.5774 = 1.1548
10	2 × 0.1763 = 0.3526	31	2 × 0.6009 = 1.2018
11	2 × 0.1944 = 0.3888	32	2 × 0.6249 = 1.2498
12	2 × 0.2126 = 0.4252	33	2 × 0.6494 = 1.2988
13	2 × 0.2309 = 0.4618	34	2 × 0.6745 = 1.3490
14	2 × 0.2439 = 0.4878	35	2 × 0.7002 = 1.4004
15	2 × 0.2679 = 0.5358	36	2 × 0.7265 = 1.4530
16	2 × 0.2867 = 0.5734	37	2 × 0.7563 = 1.5126
17	2 × 0.3057 = 0.6114	38	2 × 0.7813 = 1.5626
18	2 × 0.3249 = 0.6498	39	2 × 0.8098 = 1.6196
19	2 × 0.3443 = 0.6886	40	2 × 0.8391 = 1.6782
20	2 × 0.3640 = 0.7280		

From the point S on the line S C, the magnitudes of 0.035 meter, 0.0698 meter, etc., are measured off, the respective points are marked + 1°, +2°, etc., and the corresponding vertical lines are drawn on the wall. Analogous measurements are made on the vertical line passing through 0°, and the corresponding horizontal lines are drawn.

The patient, while steadily keeping his head upright and his face straight forward, *i.e.*, his frontal plane being vertical, and while the centre of his basal line is 1.16 meter above the point S

of the floor, holds a red glass before one eye, and looks with both eyes at the flame of a candle, which successively placed by the physician before the principal points of the system of coördinates. At each principal point the patient by the dividing lines, *i.e.*, degrees, the vertical and horizontal distances of the double-images.* The wall being so near, it requires only a moderate degree of intelligence and attention correctly to estimate ½° and ⅓°. In strictly monolateral squint the distance of the secondary image from the principal image is marked by + or − signs, according to the arrangement of the coördinates. In alternating squint (as in general), the lateral distance of homonymous double-images is taken positive, that of heteronymous double-images negative; the vertical distance is taken positive, if the image referring to the left eye is the higher one, and *vice versa*. In the tables, or in the diagram of the coördinates, the lateral deviation always is first marked, then the vertical deviation, for instance in −10, +XX° there is + 3°, −1°. In manifest diplopia the examination is made in the same way, likewise without the help of a red glass, and always also by other distances of the point of fixation.

Diplopia has frequently been measured by that *prism* which corrects it, *i.e.*, when placed before the squinting eye throws its image upon the point of fixation of the fixing eye. This would indeed eliminate the errors resulting sometimes from the inaccuracy with which patients estimate the distance of the double-images; but in the choice of prisms, which always takes a good deal of time and readily tires the patient—if we do not use a variable prism—two sources of error have to be considered, the one dependent on the asymmetrical position of the prism, the other, still more important, on the tendency inherent to the eye of fusing the double-images, a fact pointed out by A. VON GRAEFE, as early as in 1854 (Arch. f. Ophth., I., 1, p. 16).

He stated in a note that the deflections of the visual axis produced by prisms (primary deflections) might easily be recorded

* These data are the most important, for in squint operations we interfere with those muscular forces only which act in vertical and lateral directions. The antero-posterior distance, if present, is indicated in the linear dimensions, which are familiar to the patient. Wheel rotations, if they exist in the squinting eye, are seldom estimated with sufficient accuracy.

in tabular form. Such tables being, no doubt, useful and, to my knowledge, not yet to be found in opthalmological literature, I will briefly indicate the experiments and calculations which serve to compute them.

We know that in a certain position the deflection produced by a prism is a minimum—

$$d = 2i - p,$$

where p signifies the refracting angle of the prism, i the angle of incidence, when the ray of light passes symmetrically through the prism. If the coefficient of refraction of the glass of ordinary squint prisms $n = 1.6$, the following values are found by easy reckoning :

p	i	d
3°	2°22′	1°44′
6°	4°35′	3°10′
9°	7°10′	5°20′
12°	9°12′	6°24′
15°	12°	9°
18°	14°50′	11°14′

III.

Observations made with my own eyes ($M = \frac{1}{11}$), placed 18″ before a vertical blackboard, which was divided off into inches, while the prisms were held with the hand as symmetrically as possible, gave the following results :

p.	REFRACTING EDGE OF THE PRISM HELD											
	Upward.			Downward.			Toward Temple.			Toward Nose.		
	Deviation.			Deviation.			Deviation.			Deviation.		
	Primary.	Intermediate.	Definitive.*	Primary.	Intermediate.	Definitive.	Primary.	Intermediate.	Definitive.	Primary.	Intermediate.	Definitive.
3°	¼″	0	0	¼″	0	0	⅓″	0	0	¼″	0	0
6°	1″	⅔″	0	1″	0 ·	0	1″	1″	1″	1″	0	0
9°	1½″	1⅓″	1″	2″	1½″	1″	2″	2″	2″	1⅔″	0	0
12°	2¾″	2½″	2″	2¼″	?	2″	3″	2½″	2″	2″	0	0

If we experiment at a distance of 18 inches, the deviation

Of ½ inch	corresponds	to	....	1° 36′
" 1 "	"	"	....	3° 13′
" 1½ "	"	"	....	4° 45′
" 2 inches	"	"	....	6° 16′
" 2½ "	"	"	....	8° 12′

At a distance of 38″ I found—

* A. VON GRAEFE (Arch. f. Ophthal., viii, 2, p. 333) overcomes, at a distance of six feet, a prism of 30° by adduction, 6° by abduction, 1° by elevation or depression, and found that prisms of 2°, edge upward, were too strong for most people. Practice considerably strengthens this faculty. HELMHOLTZ (Phys. Opt., p. 475) can even produce deviations of 6° upwards, and of 8° towards the temple. I can overcome, for a distance of 10′, more than 3° by adduction, 6° by abduction, 6° by elevation. See also the experiments by HERSCHEL (On the Light, 1831, p. 158), to which, at the present day, little attention is paid, though they are very interesting, and already at that time taught the gymnastic treatment of squint by means of prisms.

p.	Edge Upward.			Downward.			Toward Temple.			Toward Nose.		
	Deviation.			Deviation.			Deviation.			Deviation.		
	Primary.	Intermediate.	Definitive.	Primary.	Intermediate.	Definitive.	Primary.	Intermediate.	Definitive.	Primary.	Intermediate.	Definitive.
3°	$\frac{3}{4}$–1″	0	0	1″	0	0	1″	0	0	?	0	0
6°	2″	1″	0	2″	1″	0	2″	2–4″	0	1$\frac{3}{4}$″	0	0
9°	3″	2″	0	3″	1–2″	0	3″	4–6″	0	3″	0	0
12°	4″	3″	3″	4″	3″	3″	4″	5–8″	0	3–4″	0	0
18°	7″	6″	6″	7″	6$\frac{1}{2}$″	6″	7″	8–10	10″	6″	0	0

For 38″ a deviation—

Of 1 inch corresponds to	1° 30′
" 2 inches " "	3°
" 3 " " "	4° 35′
" 4 " " "	6°
" 5 " " "	7° 30′
" 7.5 " " "	11°
" 10 " " "	14° 35′

To obtain the primary deviation free from every variation by the tendency to fusion, I further determined it with one eye, holding the prism so as to cover half the pupil.

DEVIATION.

P.	INCHES.	DEGREES.
3°	$\frac{3}{4}$	1° 10′
6°	2	2° 52′
9°	3$\frac{1}{2}$	5° 15′
12°	4	6°
18°	7	10° 12′

From this it seems evident that in binocular diplopia *prisms are more serviceable in determining the tendency to fusion than the degree of the deviation.*

Every one who thinks the construction of the system of coördinates above described to be troublesome, or not exact enough, may easily have, according to the principle of CARTER'S perimeter, an apparatus made like the one I have received from Mr. Hofmann, 35 Niederwallstrasse, Berlin. The radius of curvature of the graduated arm is 1 meter in length; it goes from 0° up to 40°; in 0°, 10°, 20°, and 40° there are secondary arms, 20° in length, cut from the surface of the same sphere, having a radius of 1 meter.

The zero-point of the principal arm is fastened to a stand 1.16 meter above the floor, but may be moved 0.3 meter up or down, the arm may be fixed at any inclination to the horizon, and the secondary arms at any inclination toward the principal arm. Thus the diplopia is measured at definite points in the sphere of the field of fixation directly by degrees of the sphere, whereas the above measurements were made in the tangent plane of the field of fixation. We are thus in perfect analogy with the determination of the field of vision. The ordinary perimeter of a radius of 12″ is too small for the determination of the field of fixation.

Some interesting results in pathological cases will be related at another time.

CLINICAL CONTRIBUTIONS TO OPHTHALMOLOGY FROM THE PRACTICE OF

DR. C. R. AGNEW, OF NEW YORK.

REPORTED BY DR. D. WEBSTER.

CASE I.—*Lenticonus.*

JAMES K. W., æt. 24, a native of New York, came to consult us about nis eyes, December 5, 1874. He stated that he had always had a slight divergent squint, and very poor eyesight, just as at present. He had tried to do different kinds of work, but had failed to satisfy himself and his employers by reason of the defect in his vision. He had gone from optician to optician without finding spectacles that would improve his sight.

Upon testing his vision for the near, it was found that he could read Jaeger No. 1 with either eye, at a maximum distance of three inches, and equally well at as near a point as the print could be approached to his eye and illuminated.

Tested for the distance: R $V = \frac{15}{200}$; with $-\frac{1}{1\frac{1}{2}}$ $V = \frac{20}{100}$; L $V = \frac{15}{200}$; with $-\frac{1}{2}^{s} \supset -\frac{1}{10}^{c.}$ axis 135° $V = \frac{20}{100}$.

Vision for reading not improved by any glass.

A four-grain solution of sulphate of atropin was then dropped into both eyes, and, the pupils being widely dilated and the accommodation paralyzed, the tests of vision and refraction gave the following result:

R $V = \frac{15}{200}$; with $+\frac{1}{10}^{s}$ $V = \frac{20}{40}$ (slowly). L $V = \frac{15}{200}$; with $+\frac{1}{10}^{s} \supset -\frac{1}{24}^{c.}$ axis 135° $V = \frac{20}{40}$.

Both eyes presented very nearly the same appearances, when examined by means of the ophthalmoscope or oblique illumination.

Upon illuminating the eye with the ophthalmoscopic mirror, the appearances were strikingly similar to those of a limited kerato-conus, the centre of the pupil seeming to be surrounded by concentric rings or, when viewed in a certain light, having the appearance of a large

oil globule. But a glance with oblique illumination was sufficient to show that conical cornea did not exist.

Throwing the light upon the eye with the ophthalmoscope at a distance of about twelve inches, two images of the fundus could be seen simultaneously. (See the accompanying Fig. 1.) The central disc-like portion

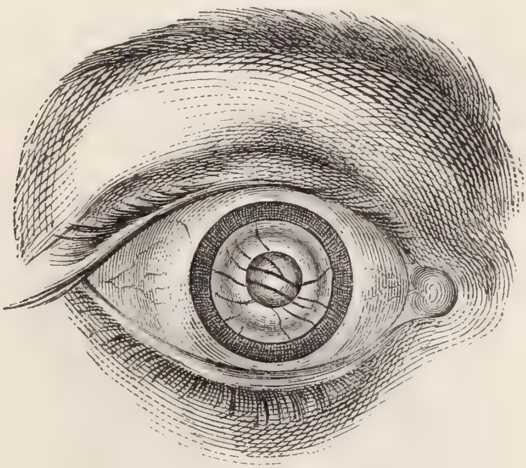


Fig. 1.

of the pupil showed blood-vessels which were suddenly lost at its periphery, and the peripherical portion which encompassed the central disc in the shape of a broad ring or zone showed blood-vessels, which appeared to terminate quite as abruptly at its inner border. The diameter of the central portion was about equal to the breadth of the surrounding zone, when the pupil was fully dilated.

The observer, on moving his head from side to side, could distinctly see that the vessels in the peripheric portion moved in the same direction, while those in the centre moved in an opposite direction. This could only be accounted for by the fact that the central portion of the eye was myopic, while the peripherical portion was hyperopic. The blood-vessels in the centre belonged to an aërial, inverted (real) image, whereas those of the periphery were seen in the virtual, upright image, which, in opposition to the former, showed a positive parallax in relation to the border of the pupil.

On approaching the eye to within half an inch, the fundus could be seen with tolerable distinctness through either a concave $\frac{1}{2}$ or a con-

vex $\frac{1}{10}$, according as the observer looked through the centre or the periphery of the pupil.

Examination by the indirect method showed a beautiful diplopia of the retinal vessels, both vertical and horizontal; and here, also, a parallax could easily be produced, the double-images being caused either to approach or to recede from one another by slight movements of the head or the objective lens.

We now come to the anatomical cause of these remarkable phenomena in the refraction of the eye. On illuminating the eye by the oblique method and looking *across* the anterior chamber, we could distinctly see the lens bulging forward at its centre in the form of a cone. Fig. 2 shows the form of the anterior surface of the lens as accurately as possible.

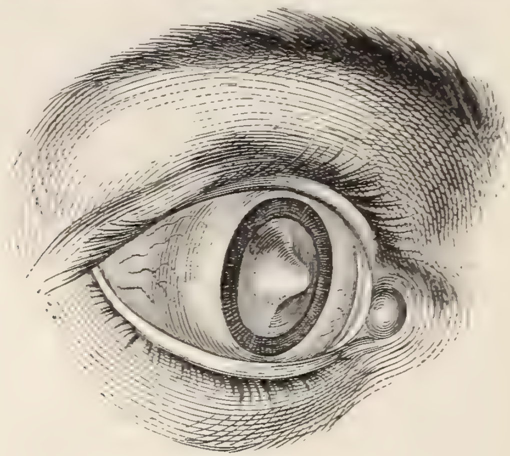


FIG. 2.

In analogy with the conical protrusion of the cornea, we have called this condition of the lens "*lenticonus*."

I may add that there was small posterior polar cataract, and that the whole posterior capsule was dotted over with very minute opacities, radiating from the posterior pole of the lens. The optic disc appeared a little too white, and there seemed to be delicate changes in the retina, probably congenital.

CASE II.—*Filamentous Opacity in the Vitreous Chambers of the Eyes.*

MISS M. H., 22, native of Ireland, applied to Dr. G. H. Bosley for relief from pain in her right eye, caused by a blow. Dr. Bosley sent her to

Dr. Agnew for examination. It was found that she had never had any defect of vision, or other trouble with her eyes, and that there were no physical signs of inflammation, past or present, to explain the cause of the neuralgia for which she had sought advice, nor was there any history of floating specks. Each eye was emmetropic with vision = $\frac{20}{20}$.

Examination with the ophthalmoscope developed a condition of things we never saw before, and which we shall endeavor to describe.

In the left eye was a filamentous body which had a dark, solid, cylindrical appearance, its anterior extremity attached to the posterior capsule of the lens, at a point about one line to the nasal side of the posterior pole of the lens in the horizontal meridian, its posterior extremity fixed in the vitreous humor at a point about 1.91 mm. anterior to the retina above, and to the nasal side of the optic disc, in the vicinity of a retinal vein. It appeared to be fixed in this position by an extension too transparent to be seen, attaching it to the vein, or to the adjacent retina.

This filamentous opacity was of uniform size, about the size of one of the primary branches of the *arteria centralis retinæ*, except at its extremities. Its anterior extremity was conical, the base of the cone applying itself to the posterior capsule of the lens, and its posterior extremity dwindled down to a point.

During movements of the eye, and for an instant afterwards, this curious body executed a series of wave-like movements, similar to those excursions which a rope would make when stretched loosely between two points and shaken.

When the eye was fixed, the filament quickly became motionless, invariably assuming the same position, forming a curved line, its concavity looking upwards.

In the right eye also there was a small opacity attached to the lens in a similar position. This also could be seen to make extremely limited excursions, showing that it was not an opacity of the posterior capsule, but an opacity *attached to* the posterior capsule by a short, transparent filament, the analogue of the more extensive opacity in the right eye.

The fact that there was no history of eye trouble of any kind, the absence of fixed or floating scotomata, and the symmetrical character of the opacities, all go to show that these lesions were congenital, and probably the result of physiological processes in the building up of the visual organs.

CASE III.—*Asthenopia from Spasm of Accommodation and Neuro-Choroidal Congestion.*

May 16, 1873. Brother A., a monk, aged 22, seeks relief from a persistent and severe asthenopia. He never had much trouble with his eyes until about two months previously, when he "began to grow very near-sighted." He became unable to recognize his friends across the street, and was obliged to hold his book much nearer than formerly. He has had severe pain in and about his eyes for two weeks, and this has increased for the last three or four days. His eyes are quite sensitive to the light. He is very nervous, trembling as though affected with slight paralysis agitans, and has a constant twitching of Horner's muscle.

He has been reading ten hours a day for the last five or six years. He gets seven and a half hours' sleep, and uses neither tobacco nor alcohol.

$V = \frac{10}{100}$; with $-\frac{1}{12}$ $V = \frac{20}{80}$, each eye.

The ophthalmoscope shows that he is not more than $\frac{1}{40}$ myopic. There is general hyperæmia of the optic nerve, retina, and choroid.

Insufficiency for 12″ 9°; none for distance. Ordered to rest his eyes and return for further examination.

May 19. $V = \frac{20}{80}$ each, without glasses. Left eye under atropine $V = \frac{20}{60}$; no improvement with glasses.

Temporal side of disc slightly excavated; a very few, delicate, punctate changes in the fundus near the macula.

Ordered atrop. sulph. gr. 4 ad. ℥ i sol. three times a day, coquilles of a medium blue tint to enable him to bear the light, and moderate exercise in the open air several hours daily.

May 26. $V = \frac{20}{50}$ each, without glasses.

June 13. $V = \frac{20}{30}$; with $-\frac{1}{48}$ $V = \frac{20}{15}$. The instillations of atropia were then stopped. The patient was ordered to continue his out door life, to adhere to a plain, nutritious diet, to attend to the functions of his skin by frictions, baths, etc., and to avoid all attempts at near use of his eyes until further instructions.

Oct. 2. $V = \frac{20}{20}$ each; Hm. $\frac{1}{36}$. With $+\frac{1}{36}$ reads Jaeger No. 1 from 8″ to 15″.

Spectacles $+\frac{1}{36}$ were then ordered for reading, and he was permitted gradually to resume his studies.

In this case the cause of the affection seems to have been long continued over-use of the eyes, together with a depressed condition of the general health, the result of his inactive, secluded

cloister life. The high degree of amblyopia was probably chiefly due to a low grade of choroiditis, affecting principally the region about the macula, the seat of direct vision. This may be deduced from the extreme chorio-capillary injection, and the delicate, punctate changes seen only in the vicinity of the macula.

The amount of lessening of the spasm of accommodation by three days of absolute rest of the eyes is remarkable, the patient seeing as well without glasses as before through a $-\frac{1}{12}$. It is still more remarkable that after a constant use of atropia for nearly four weeks, a spasm of accommodation of about $\frac{1}{20}$ still remained. This disappeared entirely in a little more than three months, under no treatment, except absolute rest of the eyes and general hygienic measures. The increase of the acuity of vision seemed to keep pace with the gradual diminution of the spasm of accommodation.

CASE IV.—*Asthenopia from Spasm of Accommodation with Astigmatism; Aggravated by the Use of Unsuitable Glasses.*

Jan. 12, 1875. H. V. L., 21, states that he had measles when eight years old, which left him with weak eyes, and at the age of ten had scarlatina, which left them weaker still. He was, however, able to use them in studying until the age of seventeen, or four years ago, when, while attending college, they gave out entirely for the first time. He was at the time arising at 3 o'clock in the morning, and studying from that hour until late at night, in order to "make up conditions." His eyes were painful, and he soon began to grow short-sighted. He consulted Dr. Agnew, who advised him to quit college and engage in some healthful out-door occupation. He followed this advice for two years, when his eyes became so much improved that he considered it safe to recommence his college life. For the last two years he has been reading, on the average, six hours a day. During these two years he has had an attack of "neuralgia" in his eyes about once a month, each attack lasting about a week, and often so severe as to cause loss of sleep. His last attack commenced on the 19th of December, 1874, while engaged in a written examination at 8 o'clock in the morning. His vision suddenly became so much impaired that he could not see to get about, and remained so for an hour, when it gradually cleared up. He had severe pain in his eyeballs, extending through the back of his head. He has had more or less severe pain ever since. He smokes and chews tobacco excessively; habits otherwise good.

He has two pairs of spectacles, which were selected for him by his father, and which he wears when occasion requires. Examination shows that these spectacles are :—

1st pair, over R E — $\frac{1}{9}$, over L E — $\frac{1}{6}$.

2d pair, over R E — $\frac{1}{7}$, over L E — $\frac{1}{9}$.

The tests of vision and refraction give the following results :—

R E V = $\frac{20}{80}$; with — $\frac{1}{24}^{s}$ — $\frac{1}{30}^{c}$ axis 25° V = $\frac{20}{30}$.

L E V = $\frac{20}{100}$; with — $\frac{1}{30}^{s}$ — $\frac{1}{20}^{c}$ axis 160° V = $\frac{20}{30}$.

Examination with the ophthalmoscope, which was difficult because of the sensitiveness of his eyes to light, showed that there was, together with ametropia, the hyperæmia of the fundus usual in such cases. He was ordered a four-grain solution of sulphate of atropia to be dropped into both eyes three or four times a day, and blue coquilles.

His photophobia and pain disappeared after the second day, and he was so pleased with his ability to face the light, that he went about the most of the time without his colored glasses.

The atropine was kept up for six days, when ;—

R E V = $\frac{20}{30}$; with + $\frac{1}{24}^{s}$ — $\frac{1}{42}^{c}$ axis 180°.

L E V = $\frac{20}{30}$; with + $\frac{1}{20}^{s}$ — $\frac{1}{48}^{c}$ axis 135°.

As it was impossible for him to remain under observation longer, we ordered the above glasses for him to wear both for the near and for the distance, and sent him home.

In a letter, dated Jan. 27th, he says :— "When I first put on the glasses everything seemed to be in a haze, but I could read with ease. However, the next morning the haze was gone, and ever since I have been able to see distinctly with them."

CASE V.—*Asthenopia from Spasm of Accommodation with Hypermetropia.*

Feb. 11, 1875. F. B. R., 16, student, complains of eyeballs smarting and aching, the latter especially on attempting to read. He has suffered for four or five years from headaches, which make him feel blind. He has slight conjunctivitis.

R E V = $\frac{20}{20}$; the weakest convex glasses blur.

L E V = $\frac{20}{30}$; with — $\frac{1}{72}$ V = $\frac{20}{20}$.

No insufficiency.

Fundus seen well with + $\frac{1}{48}$.

He has, for two or three years, noticed a tendency to bring his book up to within eight inches of his eyes. Suspected spasm of accommodation, and placed him on atropine.

Feb. 13. R E H $\frac{1}{30}$. L E H $\frac{1}{36}$.

Feb. 16. H $\frac{1}{30}$ each eye.

Feb. 18. R E V = $\frac{20}{20}$, with + $\frac{1}{20}$. L E V = $\frac{20}{20}$, with + $\frac{1}{24}$.

Stopped the atropine.

Feb. 26. V = $\frac{20}{20}$; Hm $\frac{1}{36}$ each eye. Ordered + $\frac{1}{36}$ for constant use, instructing the patient that he would, by and by, have to exchange them for stronger glasses.

CASE VI.—*Foreign Body in the Eye; Sympathetic Kerato-Iritis of Fellow Eye; Enucleation; Recovery.*

E. B., 7, was brought to our office, July 20, 1874, by his mother, who stated that three days previously, while he was playing with a toy gun, the hammer accidentally struck the cap and the "sulphur flew into his eye." Examination showed a wound of the cornea on the nasal side just above the horizontal meridian; iris apparently cut through and adherent to corneal wound: no anterior chamber from constant leakage of aqueous; lens opaque. The eyeball was considerably reddened and the tension diminished, but the patient did not complain of pain.

Nobody had thought of the possibility that a piece of the cap might have entered the eye, and no search had been made for the fragments. As it was impossible to determine whether a foreign body was in the eye or not, we decided to give the child the benefit of the expectant plan of treatment. We applied atropine and a bandage; the bandage to be removed in case of pain, and iced applications substituted.

We carefully explained to the mother that the piece of cap might be in the eye, and that if so the fellow eye would probably sooner or later suffer from sympathetic inflammation, and that in such a case the only remedy would be a prompt removal of the injured eye. She was instructed to look at the eye critically every night and morning to see if it were becoming red, sensitive to light, or affected in any way.

A low grade of irido-choroditis set in, which, without pain, resulted in atrophy of the eyeball.

Sept. 1. Seven and a half weeks after the injury, the patient comes to us with sympathetic inflammation of the fellow eye. The mother asserts that she examined the eye the night before and it looked as well as ever. This morning she found the eye reddened, moderately sensitive to light, with a good deal of impairment of sight. We found so much opacity of the refractive media that a very indistinct view of the fundus could be obtained. There were several adhesions of the iris to the anterior capsule of the lens, which did not yield to atropine used *coup sur coup*. We enucleated the injured eye in the afternoon of the same day.

Sept. 2. Adhesions have disappeared, pupil circular and dilated about one-half; still considerable redness and lachrymation.

Sept. 3. Pupil well dilated; much less redness and lachrymation.

Sept. 5. Brought to office; very little redness; numerous minute, dot-like opacities seen on posterior surface of cornea and on anterior capsule.

Sept. 11. Redness entirely disappeared; pupil still widely dilated, dot-like opacities remain. To use atropine only once a day, and return in a week.

Sept. 17. Some redness near corneal margin appeared to-day. Atropine thrice daily, and Syr. Fer. Iodid. gtt. vij. *ter in die.*

Sept. 26. The atropine has been neglected; synechia posterior at upper margin of pupil.

Sept. 28. Pupil more evenly dilated, but still much diffuse opacity of media and redness of eye. Tension reduced. Ord. Hydr. Bichlor. gr. $\frac{1}{32}$ *ter in die*, and painted brow with strong Tincture of Iodine. This painting was repeated three times with excellent effect.

Oct. 2. Pupil again widely dilated; less redness.

Oct. 21. Media remarkably cleared up, and vision correspondingly improved.

Nov. 10. Pupil normal; no opacity of media; fundus hyperæmic. The eyeball seems to be a little too soft.

Dec. 2. The child was seen for the last time. The eye seemed quite well, except a few small black specks on the anterior capsule, at the border of the pupil, the results of the broken up adhesions.

As the child had not learned his letters, it was difficult to test his vision accurately, but, as near as could be ascertained, it was up to the normal standard.

The enucleated eye was cut open, after remaining in Müller's fluid about three months. A little more than one-third of the guncap was found embedded in a filamentous mass, the result of inflammatory proliferation, lying close to the retina, at a point about two lines to the nasal side of the optic disc, and was as bright as the day it went into the eye.

The iris was in contact with the cornea, and lying close behind it was the small portion of the lens remaining unabsorbed, and surrounding it was a proliferous mass similar to that encapsulating the foreign body.

CASE VII.—*Paresis of Superior Oblique, followed by large Central Scotoma; Subsequent Atrophy of Optic Nerve; Incomplete Recovery of Vision.*

June 3. 1874. Mrs. B. came to the Manhattan Eye and Ear Hospital complaining of seeing everything double. $V = \frac{20}{20}$, each eye emmetropic. The image seen with the left eye was lower than the other, and inclined. The diagnosis was paresis of the superior oblique. The cause could not be ascertained with any degree of certainty. She gave no history of syphilis; her urine was free from albumen; she had never been troubled with malarial disease; but for the last year or eighteen months she had suffered at each of her menstrual periods with a throbbing headache, or "a beating in the top of her head."

She was ordered a saturated solution of iodide of potassium, and directed to take ten drops three times a day, and add one drop to the dose daily until some of the physiological effects of the drug were produced, and then to come and see us again.

July 10. Patient states that she saw perfectly well until a few days ago, when, one morning, soon after rising, she noticed that things looked differently from usual, so she covered her right eye, and saw only a very thick mist before the left. This mist thickened up in the centre during the day, so that her visual field became dark, except at its extreme periphery. She now is able to count fingers in the periphery, but does not see objects at all in the central portions of the field.

The ophthalmoscopic signs are negative, the refractive media and fundus appearing entirely normal.

The patient states that soon after we first saw her she was attacked with a headache, which had no connection with menstruation; a severe "neuralgia of the head" occurring once or twice a week, and lasting two or three days at a time.

The cause of her eye trouble was believed to be intra-cranial, perhaps a slight basilar meningitis. She was ordered injections of strychnine, commencing with a fortieth of a grain, and gradually increasing until constitutional effects were reached. She was also ordered to take a mixture consisting of potas. iodid., ammon. bromid., ammon. sesquicarb., and tinct. columb.

Sept. 25. $V = \frac{2}{200}$ in periphery of field, showing slight improvement. No abatement of headache. Advised to stop the strychnia, and to resort to mercurial inunction.

The ophthalmoscopical appearances are still those of a normal eye.

Jan. 7, 1875. V = $\frac{7}{200}$; the central scotoma is evidently smaller. The ophthalmoscope now shows incipient atrophy of the optic nerve.

The patient has not used mercurial inunction on account of the vulgar prejudice against the drug. Advised again to use it, as the headache is as bad as ever.

April 2. V = $\frac{20}{70}$, and central. Atrophic appearances more marked. The improvement in sight began some time after mercurial inunction was stopped. Headache still intense. Ordered potas. bromid. in half-drachm powders—one to be taken three times a day, and another at bed-time, if there still be headache.

April 16. V = $\frac{20}{50}$. Has been troubled very little with the headache since she began to take the powders. The optic nerve does not seem to have changed in appearance since the last examination.

THREE CASES OF NEURO-RETINITIS, WITH A SYMPTOM OF INTRA-CRANIAL ANEURISM.

By Dr. E. L. HOLMES, of Chicago.

Case I.—B. F., thirty-three years of age, entered the Illinois Charitable Eye and Ear Infirmary in Sept., 1871. He stated that previous to 1868 he had enjoyed uniformly good health, when he began to experience "a roaring in the head."

At the end of a year the left ear became absolutely deaf; the right ear slightly so. In a few months more the conjunctivæ began to appear congested. Soon the patient became gradually almost blind—first in the right, then in the left eye.

A casual examination revealed the following symptoms: The ocular conjunctiva of each eye was much congested; the pupils dilated, regular, and immovable. The gaze of the patient was peculiarly vacant. There was no exophthalmus, no muscular paresis, nor any pulsation in the orbits. No objective symptom of disease could be observed in either ear.

On applying the ear over the patient's right temple, a very loud aneurismal soufle could be distinctly heard, which became somewhat less loud on moving the ear to any other portion of the head or neck. The patient could partially reduce the distinctness of these sounds by pressing the chin on the left side of the sternum, and bending the head toward the right shoulder, or still more, by pressing the external edge of the right hand firmly under the jaw. He often sat with his hand in this position to diminish the "roaring" in the head. Pressure on the right carotid caused the soufle to cease. The mental and physical condition of the patient seemed normal, although confinement and anxiety had somewhat reduced his strength, if not his weight, in spite of an enormous appetite.

The ophthalmoscope revealed, in each eye, the fundus remarkably red, and the disc indistinct in outline. There were no pulsa-

tions of the veins or arteries. The sense of taste and of smell was unimpaired.

I expressed the opinion that a tumor of the brain produced the neuro-retinitis, and by its pressure on the left auditory nerve and some intra-cranial artery caused the deafness and aneurismal murmur. Although no symptoms of syphilis could be discovered, I thought best to try the effect of the iodide of potash. Ten grains, finally increased to fifteen, were given three times a day for three weeks without apparent change. For this was substituted the inunction of ung. hyd., a small quantity of which he was directed to rub into the skin with each hand twice a day. The action of the medication was carefully explained to the patient, with the injunction to reduce the quantity as soon as any of the characteristic effects were observed.

The patient either applied more of the ointment than was directed, or was exceedingly susceptible to its influence, for in five days there appeared excessive ptyalism, and great fœtor of breath. In a few days, however, the murmur in the head became inaudible, except when the patient reclined. Soon after, even in this position, it could scarcely be heard, although the patient himself still perceived it very faintly in all positions.

On the 9th of October, 1871, when the patient was still suffering from severe ptyalism, and still quite weak, he was obliged, in consequence of the conflagration which destroyed the infirmary, to leave the institution very early in the morning, and spend many hours wandering about, exposed to the violent wind and dust, without sleep and food. He was finally brought to the county hospital greatly prostrated, but soon regained his strength. Dr. F. C. Hotz, under whose care he was at the hospital, has kindly given me this portion of his history. He was treated till November with pat. iod., when he was discharged from the hospital with general health much improved. The sounds could not be heard except by the patient himself. The retina remained red—veins large and tortuous, arteries small. The contour of the discs was indistinct, although the central parts were grayish-white.

On the 14th of January, 1873, the patient informed me that his health still remained good. At times the pulsating sounds returned, with pain in the right temple, and general unsteadiness of muscular action.

His physician wrote me subsequently that the patient died in the summer of 1873. For some weeks he suffered from great muscular weakness, although he still had a most inordinate appetite. A thin watery discharge flowed from the nostrils—in the aggregate, more than a pint in twenty-four hours. He became idiotic, and finally died in spasms, after lying in deep coma for three days. No autopsy was permitted.

Case II.—W. H., six and a half years of age, was brought to me, Oct. 7, 1871, with his previous history prepared by his physicians, Drs. Lucius and D. S. Clark, of Rockford. The patient had suffered some weeks with symptoms of obscure disease of the brain. While at play he was frequently attacked with paroxysms of pain in the head, with pallor, after which he fell asleep, and on waking seemed as well as usual, although there was a strange appearance about the eyes. On the 9th of June he first visited Dr. C.'s office for advice. There were paroxysmal pains in the head and limbs, occasional vomiting, intolerance of light and sounds. The pulse was always slow—sometimes with only forty-eight beats a minute. The patient suffered from extreme thirst, and passed large quantities of urine. The bowels were habitually constipated.

Except during the paroxysms the patient did not appear to the casual observer dangerously ill, although for two days, about the middle of July, the symptoms became alarming. Already, on the 14th of June, there was double convergent strabismus, with dilated pupils, and some exophthalmos, which last continued but a short time. Vision began to fail, first in right eye, then in the left. The head was drawn back, the muscles of the neck being rigid.

Quinine, cathartics, opiates for pain, and bromide of potash were given freely, with the most favorable results, for if they were discontinued the patient cried constantly with pain. Special care was taken to keep the patient well nourished.

At my first examination the general health had almost entirely recovered, and had been good for a month, although he was still quite weak in walking, and craved large quantities of water. The important symptoms were total blindness and a peculiar aneurismal bruit in the head, which had annoyed the patient very early

in his illness. It could be heard most distinctly, just above the right temple, although it was audible if the ear was placed over any portion of the head. The patient imitated the sounds with wonderful accuracy in pitch and quality, by pronouncing in the highest tones of his voice the word "chew" in two syllables, chee-oo, the last syllable being accentuated and greatly prolonged with a slightly rising inflection.

The pupils were moderately dilated. I observed that they occasionally contracted, and learned that the patient could at any time produce this contraction at will.

The ophthalmoscope revealed a neuro-retinitis, in which there was a very marked congestion of the retina. The periphery of the optic nerve-discs was red and obscured, while the central portion was quite pale.

I expressed the opinion, that the aneurismal sounds were caused by some form of exudation pressing on one of the intra-cranial arteries. This patient also was obliged to flee for life in the night on account of the conflagration.

I saw the patient in March, 1875, and learned that the general health had continued excellent. The aneurismal murmur had ceased two weeks after my first examination in 1871. In the left eye was a cataract, which had been preceded by an extensive detachment of the retina. The pupil of this eye was somewhat contracted, while the other was dilated. The patient could still cause voluntary contraction of both pupils without convergence of the axes of the eyes, as at my first examination.

The right optic nerve disc was atrophied, being very white, with ill-defined contour. The vessels were much reduced in size. In several parts of the fundus the choroid was atrophied.

CASE III.—W. E. C., aged 21 years, who had always enjoyed good health, experienced early in January, 1871, a fulness of the head and complete deafness in the left ear, which was soon followed by a peculiar intra-cranial sound synchronous with the pulse. At first this was perceived by the patient while lying, but in a short time while sitting or standing. In the following September, vision of the left eye began to fail; two months after, that of the other eye also. By December the sense of smell had become totally, and the sense of taste partially destroyed.

The patient consulted me twice in the spring of 1872. I found a neuro-retinitis in each eye—the central portions only of the optic nerve discs being white, while the external portions were very red and ill defined. The whole fundus was abnormally red. The pupils were slightly dilated. I could discover no objective symptom of disease in the ear.

I expressed the opinion that the various symptoms were produced by an intra-cranial tumor.

On the 13th of October, 1872, the patient came to me at the Illinois Charitable Eye and Ear Infirmary with the following remarkable history. He had consulted several surgeons and an oculist in another city of most excellent reputation, all of whom, like myself, overlooked the real cause of the "sounds in the head." Finally Dr. Lambert, of Galesburg, who had seen the patient several times previously, first discovered that the sounds were not a subjective tinnitus, but aneurismal. The sounds could be distinctly heard on placing the ear on any portion of the head. They had undoubtedly been overlooked by all whom the patient had consulted, because he referred to them as if connected with the ear.

Dr. G. W. Wright, of Canton, Illinois, under whose immediate care the patient had been, tied the left common carotid, June 1, 1872, without an anæsthetic. The recovery was excellent, although a large abscess formed in the wound. The aneurismal murmur was scarcely modified by the operation.

For some time the patient had complained of a most intensely disagreeable subjective odor, which he said was beyond his power to describe. Pressure on the right carotid caused the sounds to cease, but increased the odor. I found the patient in excellent health, with no headache, no mental nor muscular derangements. Although he could walk considerably, he had observed that exercise increased the frequency of the pulse more than usual. The patient remained at the infirmary but two days. I still adhered to my previous diagnosis.

Dr. Wright kindly furnished me with the subsequent history of the case, which terminated fatally in June, 1874. During the last year of life there was extreme emaciation with progressive muscular paresis, and at times muscular spasms of the left side. All the special senses were destroyed, but hearing in the right

ear. The power of speech as well as the mental faculties remained intact till the last two days. The subjective disappeared six months before death. During this last period, the aneurismal sounds at times suddenly ceased, when a most agonizing pain attacked the right hip joint, which in turn ceased on the recurrence of the sounds.

At the autopsy a tumor as large as a hen's egg was found at the base of the brain, which proved to be an enlarged pituitary gland. This tumor pressed upon the carotid artery, causing quite a large aneurism.

In the ventricles was so large a quantity of serum that the entire white substance of the brain seemed to have been absorbed. The cerebellum appeared to be normal. The optic nerves and commissure were much atrophied and softened.

Dr. Wright kindly sent me the tumor, which I found hardened and shrunken by the action of alcohol. It was two inches in length, an inch in thickness, an inch and a half in width, and kidney-shaped.

My friend Dr. I. N. Danforth, made a careful examination of the tumor, which he describes as follows:

" The structure of the tumor is that of a typical "fibroma," or the most advanced form of sarcoma. Several varieties of morbid growths are developed upon the connective tissue type: the sarcomata appear to be fashioned after the embryonic tissue type, while the fibromata are developed after the fully formed or perfect connective tissue type. In this present instance the tumor is a pronounced example of the latter class. It is almost wholly made up of bundles of fine fibres, interwoven in all directions, so that a thin section, properly prepared, appears like an exceedingly delicate connective tela. In studying several sections of the tumor, I have found a very few groups of small round cells, and a few fusiform cells scattered here and there; thus we find the elements of the two varieties of sarcoma and of true fibroma existing in the same specimen. It is evident that, pathologically, they are closely allied; that sarcoma is fibroma in its childhood, and that fibroma is the fully developed or adult form of sarcoma."

A CASE OF DOWNWARD STRABISMUS FROM CONGENITAL PARALYSIS OF THE SUPERIOR RECTUS MUSCLE; ADVANCEMENT OF THIS MUSCLE AND TENOTOMY OF THE INFERIOR RECTUS.

By F. C. HOTZ, M.D., Chicago, Ill.

In connection with the three cases of tenotomy of the superior and inferior recti, published by Prof. Knapp in the first number of this volume, the following case may not be quite uninteresting. It has some likeness with Knapp's third case, and was operated by me in 1872.

In March of that year I was consulted by the parents of Blanche F., of Chicago. The child, æt. 8 years, was greatly disfigured by a congenital ptosis of the left upper lid, and by a likewise congenital paralysis of the left superior rectus muscle. The lid was of normal size and structure, and drooped down over the eyeball; by the utmost exertion of the musc. frontalis, it could be elevated somewhat so as to open the eye to about 6 mm.; occasionally, when the child made a special effort, the palpebral aperture was widened to 12 mm. And on such occasions I could see that the greater enlargement of said aperture was not due to an increased action of the frontalis simply in raising the lid, but it was an actual retraction of the lid by a spasmodic effort of the levator palp. sup.; for ordinarily when the eye was opened the horizontal furrow of the integument between the lid and eyebrows was smoothed out entirely (because then the lid was simply raised by traction upon the skin), but it was well marked when the palpebral aperture was widened spasmodically, because then the tarsal cartilage with the skin was drawn back over the globe by the action of the levator muscle. Although the contractions of this muscle lasted but a few seconds, they appeared to me very significant as to the feasibility of an operation for ptosis. They evidently showed the existence of a certain amount of available substance in the defective muscle that might suffice to open the palpebral aperture to a satisfactory width, if the work of raising the lid was rendered easier for it. This, I

thought, could well be accomplished by operating according to Von Graefe's method.*

The main question, however, involved in this was not that of removing the ptosis, but of remedying the strabismus deorsum vergens concealed under the drooping lid.

In the lower half of the field of fixation there was binocular fixation, which was retained until the object had come into the horizontal plane; if moved above this line, the left eye lagged behind, and the higher the object was raised the greater became the difference in height of both corneæ, because the left could scarcely be turned into the horizontal position, and certainly not above it. When the object was held in the horizontal plane, a slight divergent squint of the left eye could be noticed, and when then the right eye was covered, the left made inward rotation to look at the object, while simultaneously the covered eye moved outward. As for diplopia, no satisfactory results could be obtained. The eye was normal, emmetropic, and V = 1, and in order to see with both eyes, the girl was in the habit of throwing her head backwards, *i.e.*, to bring the objects within the lower half of the visual field.

The only remedy which would remove this strabismus in an efficient and satisfactory manner seemed to me the *advancement of the left superior rectus* combined with a simultaneous tenotomy of the left inferior rectus. From a simple tenotomy of the latter muscle only—the upper rectus being so absolutely inefficient—we could expect to gain just as little success as the simple tenotomy of the internal rectus is known to yield in a case of an inveterate and complete paralysis of the abduceus. And the idea of dividing the *right* superior rectus had to be dropped at once, because weakening of that muscle to the required degree would have strongly favored the girl's habit of reclining her head. The first object of any surgical interference in this case could not be to *lower* the position of the right eye in order to adapt it to the defective mobility of its partner; what we had to aim at was rather to *elevate* the position of the left eye. And if by an operation binocular fixation could be established in the medium range of the field of fixation, *i.e.*, in the horizontal plane, as well as to a certain degree above and below it, the result would be considered satisfactory; because then the strabismus, and consequently the

* S. Arch. f. Ophthalm., ix., 2, 59, and Soelberg-Wells' treatise on Diseases of the Eye, p. 672.

desire for throwing the head backward, would have been removed from that range of binocular movements which are most frequently called for. We could not reasonably expect to attain binocular fixation in the highest part of the field of fixation, nor would that deficiency be of any bad consequence since we find it far more convenient for such exceptional looks to turn our head than to sacrifice the less fatiguing medium position the eyes.

May 4th, 1872, the several operations were performed. The child being put under the influence of chloroform, an extensive tenotomy of the left inferior rectus was made, and at once the advancement of the left superior rectus, according to Crichtell's method, proceeded to. The tendinous insertion of this muscle was rather narrow (5 mm.), and as far as the muscle could be inspected it looked more like a fibrous ligament than muscular tissue. The tendon taken up in two silk sutures was divided in front of them, and reunited with the sclerotic close to the margin of the cornea. Finally, Von Graefe's operation for ptosis was performed. The operation completed, the cornea was turned about fifteen or twenty degrees above the horizontal line.

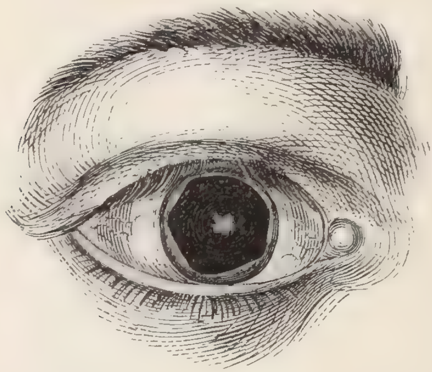
A pretty violent reaction of the lid and conjunctiva ensued; it subsided quickly, however, and disappeared entirely in the course of one week. The sutures applied in the tendon and in the lid were removed on the third day, and at both places first union was found.

Three months later, *i.e.*, at a time when, I believe, there could be no mistake as to the definite result of the operation, the left eye could be naturally opened to nearly the same degree as the right eye, the entire difference of both palpebral apertures being, perhaps, 2 mm.

The mobility of the left eye had diminished somewhat in the direction of the inferior rectus, but gained in favor of the sup. rectus so much that binocular fixation was established in the horizontal plane, and as far as 15 degrees above, and 25 degrees below it. The girl held her head straight in looking about, and for this advantage she could certainly afford to let the left eye squint a little, when the object of vision was placed in the highest or lowest part of the field of fixation.

A CASE OF RUDIMENTARY IRIS IN BOTH EYES.

By SWAN M. BURNETT, M.D., Knoxville, Tenn.



Matt. Lutterell, a negro of full blood, thirty years of age, applied to me on the 15th August, 1871, on account of his eyes, which, he said, were somewhat painful and "dazzled" in the bright sunlight.

On examination, I found no indications of present or past inflammation as a cause for the trouble. The cornea was clear ; but a glance at the deeper structures at once revealed the cause of his difficulties. The iris was present only in a rudimentary state, nothing but a narrow rim of dark-brown tissue being discernable. It did not form a continuous ring, but would at points be entirely wanting, as shown in the figure, and the connection between these points would form a straight line. On the anterior capsule of the lens, about its centre, was a small white spot, circumscribed and slightly elevated. The lens itself was clear. The fundus was normal, with the exception that the veins appeared larger and more tortuous than usual. The condition of both eyes was essentially the same. As he was unable to read, I could not determine the state of his vision correctly, but when the light was not very bright, he was able to distinguish small objects accurately. As judged by the same test, his accommodation was good. His eyes were of the emmetropic build, as determined by the ophthalmoscope. There was no other abnormality in his physical structure.

SOME CURIOUS REFLEX CONDITIONS FOLLOWING SECTION OF THE SUPRA-ORBITAL NERVE.

By GEO. STRAWBRIDGE, of Philadelphia.

My object in writing this paper is to place on record certain observations connected with section of the supra-orbital nerve, which as yet have not been noticed, or at least are unrecorded.

Case I.—A gentleman, æt. 44, consulted me some months ago on account of blepharo-spasm affecting the lids of both eyes. The chief facts in the previous history of the case are the following: The trouble began two years ago with a feeling of weight in the upper lids. This slowly increased until twitching of the lids became an annoying symptom, particularly when he was exposed to the wind—as in driving. Shortly afterwards the pupil of the right eye was noticed to be largely dilated, and reading with this eye became very difficult. Since then, up to the time he called on me, the spasm had been gradually increasing.

The examination showed the right eye to be slightly hypermetropic ($\frac{1}{60}$); $V = \frac{20}{30}$, with entire paralysis of accommodation. Pupil largely dilated; with convex glasses reads medium print with some slight difficulty. The temporal half of the optic disc was abnormally white, with a slight atrophic excavation. The retina was not at all disagreeably affected by sun or artificial light; neither was the spasm increased by it.

The left eye had a hypermetropia of ($\frac{1}{60}$) $V = 1$; otherwise normal, with exception of the lid complication.

The gentleman had, twenty years previously, suffered from a primary syphilitic attack, which had been promptly treated, and no secondary symptoms had been noticed. His general health was all that could be desired, and at no time had he been troubled with head symptoms.

From the fact of the case having been under the treatment of a number of skilful medical men, all the usual therapeutic agents had been thoroughly tried without the least benefit.

Frequent examinations convinced me that the spasm was in no

way connected with retinal irritability. (Reading, writing, and exposure to light did not at all increase the spasm.)

As a draft of wind striking the face always caused a severe spasm, I thought that, perhaps, a hyperæsthesia of some of the cutaneous nerves might be the exciting cause.

With a blow-pipe I directed puffs of air against different portions of the face and forehead without effect; but the least puff against the conjunctiva was immediately followed by a violent spasm.

My final conclusion was, that the cause of the spasm was to be sought for either in a hyperæsthesia of the conjunctiva, or in some central lesion (the latter being rendered probable from the condition of the iris and ciliary muscle, and the change in the optic disc), or possibly in both.

Pressure on the supra-orbital nerve entirely controlled the spasm.—Of this there was no doubt, as it was a matter of daily experiment for several weeks, and, therefore, section of the nerve was proposed, after all other plans of treatment had been previously tried and failed. An incision one inch and a half in length was made along the supra-orbital ridge, over the supra-orbital notch, and by a careful dissection an entrance was obtained into the orbital cavity, and the nerve drawn forward by a hook sufficiently to cut out a piece about one line in length in order that no union of the nerve could take place, and the divided ends allowed to slip back. The nerve on the other side was similarly divided at the same time; the wounds quickly healed, and for several days the spasm was much relieved, but soon afterwards returned in its full vigor, and has so continued.

Some two months after the operation, the patient one morning came to see me, with his face beaming with smiles, to say that he had found out a "way of stopping the winking." On the previous day, while riding, he happened to have a cigar in his mouth firmly held between the *incisor teeth*, and to his astonishment found that the twitching had entirely stopped—although ordinarily this would have been the most trying time. By some experimenting he then found that *firm seizure between the incisor teeth of any hard substance* was sufficient to relieve the spasm during the time of seizure. I found this statement entirely correct, and even a draft of wind, produced by fanning, directed against the face, was borne without discomfort.

Unfortunately this condition proved very transient—lasting only four days—and then the old trouble returned, and has so continued to the present time. It is proper to say that the mouth and teeth were in good condition, and that no painful points on pressure could be found.

In this case I would call attention to the fact *first*, that *although pressure on the supra-orbital nerves entirely relieved the spasm, yet section of these nerves had no such effect.*

Secondly, that two months afterwards the *spasm was temporarily relieved by pressure on the incisor teeth—a condition lasting four days.*

Several plausible explanations may be given to account for this curious condition.

The superior maxillary branch of the fifth nerve which supplies the incisor teeth of the upper jaw, by the dental branch, is also through the palpebral branches distributed to the orbicularis palpebrarum muscle and to the integument and conjunctiva of the lower lid, and then forms anastomoses with the facial nerve at the outer orbital angle, so that the temporary change, produced by pressure on the nerve distributed to the incisor teeth, could readily be transmitted to the palpebral branches of the same nerve, and so affect the orbicularis muscle—very much in the same way as by pressure on the supra-orbital nerve.

Or, again, considering that the temporo-facial branch of the facial nerve supplies the orbicularis palpebrarum muscle with its motor filaments, and that the jaw-muscles are to some extent supplied by the cervico-facial branch of the same nerve; the thought arises that, perhaps, in an active contraction of the jaw-muscles—as in this case where a firm substance was tightly grasped between the incisor teeth—the nerve-force necessary for such action would be concentrated in the cervico-facial branch of the facial nerve, and the other branches of the same nerve would be, to a great extent, deprived of it; and so the orbicularis palpebrarum muscle would remain at rest from the fact of the temporo-facial branch of the facial nerve—this muscle's motor nerve—being to some degree deprived of the nerve-force.

If this be a true theory, namely, that if the nerve-force of any given nerve be concentrated in any particular branch of this nerve, the remaining branches will be to a great extent deprived

of it, it would form a most important principle in the treatment of diseases of the nervous system.

The very transient duration of this curious condition is, however, a strong point against both of these theories.

CASE II.—Was that of a man, æt. 27, who applied for relief from neuralgia of the supra-orbital and temporal branches of the fifth pair of nerves, of ten years' standing.

The first symptom, noticed now more than twelve years ago, was failure of sight. Choroidal congestion and hypermetropia were diagnosed by his physician, and for this he was treated with some benefit. Neuralgia of the supra-orbital nerve soon followed, and this had continued since that time.

An examination of this case developed the following :

Right eye $H = \frac{1}{7}$ with correction $V = \frac{20}{70}$ (reads Sn. 3 at 7″).

Pupil very large. The temporal half of the optic papilla was abnormally white, and the corresponding visual field slightly contracted.

Left eye $H = \frac{1}{9}$, with correction $V = \frac{20}{70}$ (reads Sn. 2½ at 8″).

Pupil large. Same change in the optic disc and visual field as in right eye.

Over the entire supra-orbital and temporal regions extreme tenderness existed ; the lightest touch of the finger caused exquisite pain. This condition was almost continuous, although, occasionally towards night, the pain increased ; also, on several occasions I found the patient suffering from a severe attack of periosteal neuralgia, with considerable conjunctival chemosis. The general health was good.

Every imaginable treatment had been tried during the preceding ten years by the numerous medical gentlemen consulted, without the least permanent benefit. A long sea-voyage had proved of the greatest use to him, but always on his return the old trouble reappeared.

I therefore determined on section of the supra-orbital nerve, as in this region the pain was the greatest.

An operation, similar to that performed in the first case, was done on each side, excising a section of nerve fully one line in length, which was followed by almost entire anæsthesia of the forehead, as in the former case.

At a visit 24 hours after the operation, the patient complained

of a *great want of taste*, and by experimenting with several articles, I found that there existed almost entire *absence* of *taste.* For instance, quinine, muriated tincture of iron, and other intense bitters, were not noticed as at all bitter ; any article of food was remarked as simply a fluid, or solid, as the case might be.

This condition lasted four days, and was followed by a slow reëstablishment of this sense. Two weeks later it was again perfect.

The result of the operation was entire relief from pain in the supra-orbital region. The forehead anæsthesia still exists—now three months after the operation—although not to the same degree.

In this case I have been greatly puzzled to account for this strange loss of taste, from such a cause as section of the supra-orbital nerve, and the more so as the other branches of the fifth pair showed nothing abnormal after the operation.

There exist numerous examples of fifth pair paralysis, accompanied with loss of taste, caused in a great number by some central lesion ; and, again, there are a number of cases of complete paralysis of the same nerve, also caused by central lesion, where, strange to say, the sense of taste was in nowise affected ; but in this case we have an example where section of one branch of the fifth pair (the supra-orbital) caused paralysis of another branch of the same nerve (the gustatory) without the remaining branches of the same nerve being in any way altered in their functions.

The curious reflex phenomena shown in these two cases were to me most interesting, while, at the same time, I was greatly puzzled to account for their occurrence in a satisfactory manner ; but I have no doubt that, as our knowledge of the physiological action of the nervous system increases, these (at present obscure) pathological conditions will be of easy explanation.

POSITION OF THE GLOBES WHEN THE LIDS ARE CLOSED.

By Dr. E. H. HOLMES, of Chicago.

A few years ago I accidentally discovered a fact regarding my own eyes, which I observed in three out of eleven friends, with whom I experimented. I do not know that the phenomenon has been referred to by any author.

When I fix my eyes on a small black object, placed on a white blank wall, or a very small isolated gas-light in a dark room, at the distance of twenty feet, more or less, then close the lids for a moment, endeavoring mentally to fix the eyes on the object, and finally open them suddenly, I perceive two images, one directly above the other, a foot or more apart. These images more or less slowly coalesce.

If the head is turned to either shoulder, the images still appear perpendicular to the line joining the centre of the two pupils.

The images are more vividly perceived when the eyes are somewhat weary from want of sleep—or the muscles partially relaxed by inhaling a small quantity of chloroform.

Winking quite rapidly causes the images to approach each other in lines considerably curved.

A glass, tinted blue or red, held before one eye during the experiment, renders the diplopia remarkably distinct, especially if the lids are closed and opened deliberately several times in the course of a few minutes.

When a bright star—the planet Jupiter for instance—is observed as above described, a red piece of glass being held before the left eye, the upper red star falls down to the stationary image ; if the glass is held before the right eye, the lower red star rises up to the other.

My eyes are practically normal, although my right eye, on passing at once from daylight to a dark room is almost absolutely *blind* long after the other eye is able to see quite distinctly.

On theoretical grounds I would suppose the double vision in the cases described would be lateral. It seems that in certain individuals, the inferior and superior and possibly the oblique muscles, are unequally relaxed when the lids are closed.

On suddenly opening the eyes, a second or more is required for a perfect consensual action of these muscles to be reëstablished.

I may add that I found the images, in a case of insufficiency of the internal recti, to move obliquely.

AN ORDINARY STRABISMUS OPERATION, FOLLOWED BY TENDINITIS—PERFORATION OF THE SCLEROTIC—DETACHMENT OF THE RETINA—RECOVERY.

By THOMAS R. POOLEY, M.D., of New York.

ACCIDENTS following the operation for squint are fortunately very rare. It becomes all the more important, for this reason, to report those which do occur. The succession of events which took place in the case which I am now about to report, are of such unusual interest as to seem well worth putting on record.

On the 27th of Nov., 1874, I operated upon the left eye of Mary L., æt. 27, for an ordinary strabismus convergens concomitans of about $3\frac{1}{2}'''$ in the St. John's Riverside Hospital at Yonkers. The operation, which was entirely sub-conjunctival, was accomplished without the least mishap in four or five strokes of the scissors. The next morning there was no unusual reaction. It was only after the operation was performed that I learned that the patient had had intermittent fever, most of the time for three years, and that she was under treatment for this affection in the hospital at the time when I operated. She was very pale and debilitated, and had the appearance of a person who had suffered for some time from an exhausting disease.

My brother, under whose care I left the patient, says that inflammation began the next day. He kept her in bed and made cold applications, but the swelling of the lids, protrusion of the eye, and chemosis became so great that he grew alarmed, and sent her down to the city to see me.

Dec. 2d.—There was then marked exophthalmus, impediment in the motions of the globe, great swelling of the lids, and serous chemosis overlapping the cornea.

I sent her back with the directions to apply warm applications, and to return to my office in a few days, which she did on the 7th of Dec. I was now very much alarmed at the condition of the eye, and feared that sloughing of the cornea would soon ensue. The same day she was admitted to the N. Y. Ophthalmic and Aural Institute. The condition of the eye as then recorded, is as follows: There is great swelling of the eye-

lids, which are so tense as to render them almost immovable; the globe is protruded between the lids; the ocular conjunctiva, swollen and chemotic, overlapping the cornea to such an extent that only the pupil can be seen. The cornea was still transparent; iris acts well, and the interior of the eye is normal. Movements impeded in all directions.

The patient suffers great pain, and there is some constitutional disturbance.

Dec. 8th.—Swelling and chemosis have increased, being greatest over the insertion of the divided tendon. Several incisions were made in the chemotic conjunctiva, with the scissors, only a little blood escaping.

Dec. 11th.—Chemosis has increased still more, and there is a distinct protrusion over the muscle.

Dec. 12th.—The protrusion was so great that I suspected there was pus under the conjunctiva, and determined to snip the conjunctiva; in so doing a small quantity of thin pus escaped, which was immediately followed by a gush of perfectly healthy vitreous, as I had cut into the sclerotic. Immediately following this accident, the anterior chamber deepened to twice or three times its natural depth, the iris being greatly retracted. The ophthalmoscope showed striped detachment of the retina, and the vision, which had hitherto been unaffected, sank to perception of light. A pressure bandage was at once applied and strict quiet enjoined. The next day there was some pus on the lint. The wound gaped widely, and during the examination, in spite of great care, some vitreous escaped. There was no abatement in the swelling of the lids or chemosis; the cornea, however, remained clear. For fear of further loss of vitreous the eye was not examined with the ophthalmoscope; Tn, and the same condition of the anterior chamber.

Dec. 14th.—The wound of the sclerotic apparently closed, but the whole region bulges and has the appearance of a forming abscess. Anterior chamber not quite so deep, tension less diminished. The patient has excessive sweating, which was supposed to be a relic of intermittent fever, for which sulphate of quinine with an excess of aromatic sulphuric acid was ordered.

Dec. 16th.—On removing the bandage the patient pressed the lids together forcibly, and another escape of vitreous took place; the bandage was at once reapplied.

Dec. 17th.—Had severe pain last night; lids not more swollen; bandage applied without opening the eye. For the next ten days the bandage was only removed to clean the lids, and at once readjusted, without making an examination of the eye. The swelling of the lids became daily less and the tension improved.

Dec. 29th.—Examined the eye. The wound of the sclerotic was firmly closed, with granulations over the scar; anterior chamber had regained its normal depth; the chemosis had almost gone, and the movements of the eye were restored. Tn, no divergence; counts fingers at 2'. F. entirely wanting upward and outward. OS. examination shows opacities in the vitreous and detachment of the retina downward and inward. The next note of the patient's condition was made the day she was discharged from the Institution, Jan. 6th, 1875.

There was from $\frac{1}{4}$–$\frac{1}{2}'''$ of dynamic convergence under the covering hand, and fingers were seen at 10'; no longer any limitation of F., although with the ophthalmoscope, the lower and inner part of the retina was of a grayish-blue color, slightly raised, with fulness and tortuosity of the vessels as seen in incipient detachment.

About two weeks later, the patient came to my office. The granulation over the site of the wound had quite disappeared, and the caruncle was considerably sunken. The scar in the sclerotic, which is about 2''' in length, is somewhat prominent and shows the choroid shining through. Mobility of the globe inward is greatly impaired, so that the margin of the cornea only reaches the lachrymal point. There is slight dynamic convergence under the covering hand, but none in binocular fixation. Tn, and F complete. H $\frac{1}{24}$, S $\frac{20}{200}$, Sn. $3\frac{1}{2}$, R H $\frac{1}{30}$, S = $\frac{20}{20}$. There was no longer any evidence of detachment of the retina, which was everywhere even, and the vessels no longer tortuous. There was still some opacity of the vitreous, and atrophic spots in the choroid, especially in the neighborhood of the wound. But the most remarkable appearance presented itself in that portion of the fundus which exactly corresponded to the wound of the choroid, where there was a large, crescentic, shining white patch, strikingly like an isolated rupture of the choroid in appearance. It was about 2 ds. of the od. in length, with the convexity of the crescent looking towards the disc, and surrounded by other atrophic spots and pigment heaps. The retinal vessels could be distinctly traced over it.

I examined the patient for the last time, March 4th, 1875. There was no longer any protrusion of the scar. The wound was evenly and firmly united. V had risen to $\frac{20}{70}$.

The mobility inwards was but slightly impaired and there was a tendency to divergence upon fixation. The eye was quite free from pain or annoyance of any kind.

There are several points of interest in this case, and the first one which suggests itself is, that very considerable reaction may follow even a carefully performed operation performed for strabis-

mus, which might even result in the loss of the eye. I have no doubt but that in this case the miserable condition of the patient's health had a good deal to do with the severe inflammatory process which ensued. I am quite sure that, had I known her condition, I would not have performed the operation.

The opening of the sclerotic can only be explained by the softening from maceration by the sub-conjunctival effusion, giving rise to a staphylomatous protrusion at this point, with thinning of the tissue, so that it was readily cut into when I made the opening with the scissors.

Another interesting point is the occurrence of detachment of the retina, which must have been caused by the sudden loss of vitreous, causing collapse of the globe, as shown by the great retraction of the iris. It is also worthy of notice, that complete recovery from a very considerable detachment of the retina took place, thus showing that the probability of recovery from traumatic detachment, as has also been observed by Von Graefe and others, is much more likely to occur than in cases from other causes. It appears, too, from this case that wounds which open into the vitreous chamber, are not so dangerous for the integrity of the eye as we have been in the habit of considering them, and opens the question whether we may not be more daring in resorting to them when necessary to remove foreign bodies, etc.

If the swelling of the lids and conjunctiva had not been so great, I should have resorted to the use of a suture for closure of the sclerotic wound, but it is evident that this procedure would have been quite impossible in this case. I have, however, made use of it in a case of simple lacerated wound of the sclera with very good results, (see Transactions of Am. Ophth. Soc., for 1873,) and have seen it done with the same good effect by one of my colleagues in the N. Y. Ophthalmic and Aural Institute.

ON FOREIGN BODIES IN THE INTERIOR OF THE EYE.

By Dr. B. B. SCHWARZBACH, of Philadelphia, Pa.

Not only on account of the mostly very serious consequences resulting from foreign bodies which enter the eye, nor either on account of their frequency, should all such cases be recorded in the ophthalmological literature, but the detailed description of such injuries, their treatment, and its result—if conscientiously recorded and published—may, at some future period, furnish statistical data for determining the proper time of surgical interference and its value. To-day these points are in many instances left to the individual judgment of the physician, and fill his mind with doubt and hesitation.

The chapter on the therapeutics of foreign bodies in the interior of the eye can by no means be considered as concluded ; just as positively as some renowned oculists of the present day urge the *enucleatio bulbi* in all cases where foreign bodies have penetrated into the posterior part of the eye, even if no inflammatory irritation is experienced ; just so urgently do others advise to proceed with the enucleation only when an inflammatory process—especially *cyclitis*—is present. The question whether the extraction of a traumatic cataract, while a foreign body is imbedded in the lens, should be preceded, some weeks, by an iridectomy or not, has not been unanimously answered. The same may be said of many other important questions on this subject, which I shall not attempt to solve, knowing that only the *status quo* of the disease decides on our surgical interference. Even the location of a foreign body in the interior of the eye does not absolutely influence the prognosis ; since a change of its position may essentially alter the character of the affection.

Being convinced that faithfully-recorded observations are not without importance to the ophthalmic surgeon, I shall report, without comment, the six cases of " foreign bodies in the interior

of the eye," which it was my privilege to observe, during the winter of 1874–'75, in the Eye Infirmary of Dr. Hirschberg, at Berlin, who kindly gave his consent to my publishing these cases, and consulting his clinical journals for that purpose.

CASE I.—A young locksmith presented himself at the Clinique at the end of the year 1874. Only a few days previously, while hammering, he had injured his left eye, the sight of which was at once abolished, but regained soon after. Since then he complained of seeing "flakes." The eye shows pericorneal injection ; there is no abnormity discoverable in the lens, but extensive membranes are floating in the *vitreous humor*, in the lower portion of which large brown coagula can be seen. The papilla optica and its surroundings are clouded, the vessels of the retina dilated. In the lower-outer region of the fundus a snow-white and roundish figure is seen, the diameter of which is $1\frac{1}{2} - 2$ times as large as the diameter of the papilla. The retina is ecchymotic around the white figure, at the inner side of which is a large coagulum, brown in its densest part, projecting far forward, swaying to and fro with the movements of the eye, and, consequently, sometimes covering the white figure. By this white patch the retinal vein (V. temp. inf.) is interrupted in such a manner that its inner upper part appears immensely dilated and tortuous, showing that its circulation has not been cut off. The eye reads Sn. $1\frac{1}{2}$, and has no defect in the field of vision. Solution of atropia and rest were ordered. A fortnight later the irritation was less. The whole patch showed some parallactic movements of its somewhat irregular foreground towards the vein. Corresponding to the inclinations of the head of the examiner, the lateral border of the patch obscures the coagulum more or less. The diagnosis of a foreign body having thus been ascertained, it became necessary to trace the way it took. By aid of the ophthalmoscope a bluish cord could be traced from the white patch forward, and could be found, by focal illumination, close behind the lens. Immediately below the horizontal diameter of the cornea, and near its border, we observe a narrow, opaque cicatrix, $1\frac{1}{2}$–2 mm. long—evidently the result of a previous perforation. In its rear we discover a similar whitish spot in the iris, with newly-formed blood-vessels. From this a peculiar, circumscribed, dimly-defined, tube-like passage penetrates the lens, which otherwise is perfectly clear, and especially free from radiating opacities of the posterior cortical layers. In the anterior part of the lens this tube-like passage is not filled, and its outlines may be recognized by ophthalmoscopic illumination as two parallel dark lines, lying closely together (very much like the double contours of a vessel). The above-described cord in the vitreous humor is a

continuation of the tube in the lens. Besides this, two little lumps can be seen in the front part of the vitreous humor, and some brownish, sessile membranes in its lower part.

With — 15 the foreign body could be seen very distinctly in the upright image, and especially the edge turned towards the papilla, while it was necessary to use — 12 for the plain recognition of the papilla itself. Therefore, the foreign body projected forward, mainly with its inner edge, over the level of the background of the eye. The papilla and its surroundings are still slightly infiltrated. In the reversed image it is to be plainly seen that the border of the white patch shows parallactic movements relative to the adjoining parts of the retina (blood-vessels). Undoubtedly we have here a foreign body, the boundaries of which seem to be somewhat different, as seen from different positions. The differences are but inconsiderable, the foreign body being comparatively small. The surface of the foreign body is snow-white, only in its centre is a grayish color visible. The coating of blood covering the foreign body has become thinner and less extensive. In the lower part of the retina are circumscribed hemorrhages, from which thin, brownish membranes project into the vitreous humor.

Two points in this ophthalmoscopic picture may be difficult to explain :

1. The white color of the foreign body ; 2. The hemorrhages in the lower region of the retina and vitreous body.

It is possible that the foreign body had impinged upon the place where the white patch was situated, and had fallen to the bottom of the eye. It is certainly to be considered in No. 2, that in seemingly slight contusions of the eyeball, while yet the finest print can be read, hemorrhages in the retina are rather frequent and extensive. In regard to No. 1, the further observation was decisive. The power of sight remained as before described. One month after the foregoing statement, a grayish stripe was seen (in the upright image), extending diagonally across the white patch ; evidently a metallic substance which was capsulated by a thin tissue. On the upper edge of the gray stripe a small black point made its appearance. The blood which had surrounded it was almost absorbed. A white line accompanied the vein leading from the foreign body to the papilla. The retina was much clearer. With + 6 Sn. $1\frac{1}{2}$ could be read ; the periphery of the field of vision was normal. The perimeter showed a paracentric scotoma in the 11th meridian, from 32 to 48 degrees.

Middle of February, 1875, when the patient left Berlin, his condition was unchanged.

Not always do similar injuries take such a favorable course, even if the foreign bodies are small and metallic, that is, if they act only in a mechanical and not in a chemical (caustic) way.

Case II.—The blacksmith, P., 24 years old, presented himself, November 23, 1874, immediately after receiving an injury of the left eye, while he was hammering. The right eye was normal; Sn. = 1. The left eye counted fingers in 6″, was almost without irritation, but showed in the center of the cornea a lineal mark of about 3 mm. in length, besides opaqueness of the lens. Unfortunately he could not then be admitted to the hospital. Instillations of atropia and a compressive bandage were ordered.

On the 24th of November, the iris was discolored, greenish, and a small hypopyon visible.

On the 25th, he was admitted. The hypopyon had disappeared, the irritation was inconsiderable, the perception of light was moderate, and a defect of the lower part of the field of vision could be stated. The diagnosis was a foreign body in the interior of the eye. The perception of light was soon totally lost without apparent irritation. The painfulness by touching the region of the ciliary body continued, and as the anterior chamber contracted more and more, the iris and the lens were bulging forward, and the tension of the eyeball diminished, the "prophylactic" *enucleatio bulbi* was performed on the 13th of December.

The eyeball was sent to Professor O. Becker at Heidelberg, who, under date of February 15th, 1875,—transmitting a splendidly executed photograph of the section of the eyeball,—wrote to Dr. Hirschberg, that the foreign body had penetrated the retina near the junction of the optic nerve, and thence rebounded downward. The retina was intensely inflamed, but a small part of it was detached. The vitreous body contained numerous disseminated patches of matter; the ciliary body was likewise inflamed; the lens was misshapen, showing a conical projection toward the corneal scar.

To complete the review of the pathological importance of *corpora aliena* in the interior of the eye, we shall now examine their passage, tracing it from the rear of the eye forward, through vitreous body, lens, anterior chamber, and cornea—guided by some new observations.

Case III.—Johanna S., 10 years old, had injured her right eye on the 6th day of October, 1874, by the explosion of a cap. *Stat praes.* $\frac{14}{10}$,74 :

Pericorneal-injection and watering of the injured eye. In the periphery of the cornea, on the boundary between the upper and outer quadrant, is to be seen a radial line or scar, about 2 mm. long, behind which the papillary edge of the iris is torn ; the pupil is not much dilated, and is broadly adherent (near the torn part) to the anterior capsule of the lens. Whitish reflex from the depth. The tension is lessened ($T-1$). The eye discerns only movements of the hand. After artificial dilatation of the pupil, it is perceptible that from the upper extremity of the defect of the iris, a cloudy stripe passes in an axial direction through the periphery of the otherwise transparent lens, and spreads, fanlike, in the posterior cortical layer ; in its broad central base the intensely white linear scar of the posterior capsule can be seen. To this spot of the crystalline lens numerous fanlike membranes floating in the vitreous humor are attached by a thin stem. The ophthalmoscope shows in the upper part a reddish, in the anterior part a grayish blue, and in the inferior part an intensely bluish reflex. From this we infer, that a fragment of the cap has penetrated cornea, iris, lens, and vitreous body, rebounded from the back of the eye, and is situated on its bottom, although it could not be directly seen.

The cloudiness of the vitreous humor gradually disappeared. On the 7th Nov. the eye counted fingers at a distance of 8 inches, and was entirely free from irritation. On the $\frac{28}{11}$, there were visible only narrow, filamentous, floating opacities (in the stead of the broad membranes), adherent to the scar of the posterior capsule. The posterior layers of the lens showed faint cloudy lines besides the circumscribed patch. On the $\frac{7}{12}$, the eye counted fingers at $6'$. On the $\frac{28}{12}$, the vitreous humor had sufficiently cleared up to verify the diagnosis. Both by focal and ophthalmoscopic illumination, a bright reddish fragment of metal could be seen near behind the posterior capsule of the lens, and a little above the level of the lower periphery of the lens. After its location was well known, the fragment of metal could easily be recognized with the naked eye by daylight and, although less distinctly, when the eye was directed downward and then moved quickly from right to left. By this movement the metallic polish of the copper was clearly seen. The bottom of the vitreous humor below the fragment remained bluish-white. In January, 1875, the incapsulation of the metallic particle commenced, so that only a part of its surface was shining. This condition has continued, and the eye was not inflamed.

More gratifying than such undecided cases, are those in which the extraneous body is arrested in the crystalline lens.

CASE IV.—Wood turner, K., 36 years old, was examined in the clinic on the $\frac{30}{11}$, 1874, a piece of wood having imbedded itself in the left cornea. During the examination there was discovered in his right eye, which was entirely free from irritation, and the examination of which the patient thought unnecessary, a posterior adhesion in the inner and upper quadrant, and a circumscribed, striped opacity of the lens. The pupil was too much contracted to admit of a closer observation. The eye read Sn. 4 in 5″, and did not show any defect in the field of vision. The left eye read the finest print, and was ophthalmoscopically normal. About cause and commencement of the defect of sight of the right eye, the patient could not give any information. After a while he was inclined to ascribe it to an attack of cholera, from which he had suffered fifteen months before.

On the following day, after artificial dilatation of the pupil, there was observed on the right side : (1) in the inner and upper quadrant of the cornea, not far from its centre, an oblong, narrow, white cicatrix, resulting doubtless from a perforation ; (2) behind this and a little lower in the anterior capsule of the lens, a white, sharply circumscribed scar, the same which was observed the day before ; (3) below and behind this capsular scar a flat *fragment of iron* located near the centre of the transparent substance of the lens, being approximately $1\frac{1}{2}$ mm. in length and 1 mm. in thickness ; its front part showed a metallic polish, the remainder was dark. When the patient slightly raised his eye, the cicatrices of the cornea and of the anterior capsule were, with the fragment of the iron, on a straight line, which extended from the inner-upper to the lower-outer part. In the posterior capsule of the lens, there was a delicate radiating opacity as could be expected. A tube-like track of the foreign body through the anterior layers of the lens could not be traced. The background of the eye appeared quite normal. Evidently the foreign body had been in the lens a short time only, otherwise it would have caused greater changes on account of its large size.

The patient presented himself several times. The dimness of the lens increased rapidly. As early as the 27th of December, the eye could only count fingers at 7″. On the 6th day of January, 1875, he complained that 3 days before, he was attacked by the most violent pains in the right eye. Leeches, opiates, instillations of atropia, and applications of ice to the head were ordered. Pericorneal injection and smoky opaqueness of the cornea were present ; the pupil was above medium size and regular ; the lens was completely opaque and swollen in its nasal half, while the tension of the eyeball was increased (T+1). The foreign body was no longer visible either by unaided inspection or by focal illumination. Who-

ever had seen the patient in the present condition only, would have had great difficulty to make the diagnosis. He was at once admitted to the hospital. It was determined to extract the lens and the foreign body by means of a corneal flap-section. Iridectomy alone might possibly remove the increase of pressure, but not its cause. Of the various methods of extraction, the corneal linear cut seemed to be too small, and Von Græfe's peripheric linear section inappropriate for the manipulation of the forceps; besides involving prolapse of the vitreous body, which frequently occurs in traumatic cataract, and in this case, was anticipated on account of the increase of the pressure in the eye. Considering the youth and excellent health of the patient, the prognosis of a corneal flap was very favorable ; the soft consistence of the swollen lens seemed to require only a flat flap.

On the following day $\frac{7}{1}$, '75, the operation was performed without narcosis by Dr. Hirschberg, myself assisting. The cut was made in the usual manner, the puncture and contra-puncture being about $1\frac{1}{2}$ mm. above the horizontal meridian. A part of prolapsed iris was immediately removed ; small forceps were now introduced, and where the foreign body was expected to be found, the anterior capsule and the surrounding layers of the lens were seized, upon which the whole lens together with the foreign body escaped. The foreign body was somewhat smaller than estimated, viz. ; 1 mm. long, $\frac{3}{4}$ mm. broad, and $\frac{1}{2}$ mm. thick. The healing process took the most satisfactory course.

On the $\frac{23}{1}$, the eye read with + 4 Sn. L. in 20′, with + 2 Sn. $2\frac{1}{2}$ in $4\frac{1}{2}''$, on the $\frac{27}{1}$ with + $2\frac{1}{2}$ Sn. $1\frac{1}{2}$ in $4\frac{1}{2}''$. Four weeks after the operation the patient was discharged.

If it is appropriate to conclude the history of a disease, like a fable, with a moral, we are taught by the above case that we can only trust in objective examinations, and how very important it is carefully to keep clinical journals, most patients being such superficial observers that the physician cannot rely on their statements so much as on his examination. A patient presents himself with a piece of wood in the cornea, and it is found that he has also a fragment of iron in the interior of the eye. Another presents himself with a foreign body in one eye, while the iris of the other eye contains a piece of steel. A third patient appears with *keratitis traumatica dextra* and has in the left eye a *cysticercus intra-ocularis*, without ever having thought to complain of the latter. The exact knowledge of the foreign body in the lens was

of great importance in the case above described, because at the time of the operation it could no more be perceived.

If a metallic fragment is detected in a transparent lens, we can not assume that the lens will permanently retain its transparency. Sooner or later the lens will be opaque, but not always under such violent symptoms as in the case last described.

If a foreign body has penetrated into the anterior part of the lens only, it is advisable to extract at first but the intruder (mostly by an iridectomy), while the lens is left untouched. Two circumstances there are that contra-indicate in a direct way the immediate extraction of the lens : (1) Partial opacity of the lens ; *i.e.*, immature traumatic cataract ; (2) shrinkage of the crystalline body. In the first case it is difficult to remove the lens, for mechanical reasons ; in the second, prolapsus of the vitreous body is to be apprehended.

I could illustrate each of these two cases by conclusive examples ; but as I had no opportunity fully to watch the respective patients, who were also treated in Dr. H.'s clinics during the last winter, I limit myself to the following short statement.

Very small fragments frequently do not even reach the lens, but remain in the iris. Diagnostically interesting is the following :

Case V.—Richard F., 16 years old, presented himself during the end of February, 1875, nine days after he had injured his right eye, while hammering. A cursory examination showed the aspect of an *iritis :* sensitiveness, watering, pericorneal injection, the iris discolored, greenish, while that of the other eye was blue. Closer examination revealed in the inner-upper quadrant of the iris a white patch the size of a pin's head, on the upper end of which the black edge of a minute fragment of iron was barely recognizable. Focal illumination showed in front of it a very small linear cicatrix of the cornea. The eye still read fine print : Sn. 2 in 6″.

Iridectomy was at once performed, and followed, as is usual in such cases, by good success.

If the power of percussion is very small, the foreign body may entirely remain in the exterior coats of the eye or penetrate only with one end into the interior.

Case VI.—On the $\frac{16}{12}$, '74, a glazier's apprentice, æt. 15, came to the

clinic and stated, that on the forenoon of the same day, a piece of glass had struck his right eye. The eye was moderately irritated. A radiating linear wound of 2 mm. in length is in the sclerotic, at the outer-lower margin of the cornea. A hard black body projects out of the wound.

Attempts to seize it with forceps of different kinds failed. The wound was then carefully made gaping (behind the foreign body) by means of a curved probe. The foreign body was caught between the lips of the wound with fine, straight iris-forceps and slightly loosened, then seized with stronger forceps and gradually extracted. It was a crooked, small piece of *iron* (no glass splinter), which had lodged behind the sclero-corneal junction in the anterior chamber. A slight prolapse of iris was partially reduced, a small wrinkle of the iris remaining in the inner part of the wound. The aqueous humor did not escape during the trifling operation. A bandage was applied, a solution of atropia instilled, and on the following day the wrinkle in the iris had disappeared.

I shall make no remarks about the foreign bodies in the *anterior* part of the eyeball, as such cases are of every-day occurrence in all larger mechanical establishments and familiar to every oculist.

In concluding these remarks "*on foreign bodies in the interior of the eye*," I may state that I have by no means exhausted the fund of observations made in the eye-clinic of Dr. Hirschberg, during my visit in Berlin. The selection of the above described cases, which were observed in so short a time, and in one and the same place, may demonstrate the practical importance of this subject.

ON THE ANATOMICAL CHANGES FOLLOWING IRIDECTOMY.

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(With Plates XIII. and XIV.)

Considering the great prominence which the operation of iridectomy has attained in ophthalmic surgery, it is surprising that heretofore no investigations have been published, which treat of the anatomical relations noticed during the healing process after this procedure. The readiness with which everything was put at my disposal in the Pathologico-Anatomical Institute of Heidelberg, by *Prof. J. Arnold*, enabled me to ascertain, by way of experiment, some positive data, which will be the subject of the following remarks:

The experiments were made on rabbits. The majority of operations were performed on albinotic animals. The rabbit, however, is an unfavorable subject as to kind healing of iridectomy wounds, on account of the peculiar anatomical construction of its iris, of which Hampeln has given a good description in his monograph, entitled, "*A Contribution to the Anatomy of the Iris.*" Dorpat, 1869.

Another unfavorable fact is the following: The rabbit, during the performance of the operation, contracts its eyeball so much that it is almost impossible to prevent a prolapse of the iris with subsequent adhesion of the iris and the ciliary body to the corneal wound, even when this prolapse can be obviated, either by causing the protruding iris to retract by means of gentle rubbing on the cornea, or replacing it with the forceps, which may be done in the rabbit's eye without any evil results. The animals, after one or two days, commonly reopen the wound by almost constantly scratching it, thus producing a fresh prolapse and its consequences.

It is owing to these difficulties that my observations on the anatomical conditions, exhibited by a *normal* healing process, are not so extensive as I might have wished. But on the other hand, my observations on the *abnormal* healing processes were so abundant that a description of the pathology of iridectomy did not appear without interest.

I.—*On the Normal Healing Process of Wounds of the Iris.*

During the first hours and days after an iridectomy, a coagulum tinged with blood is noticeable in the wound—that is, if the pedicle of the iris is not enclosed in the cornea-scleral wound. This coagulum will persist unchanged for some time if the hemorrhage has been profuse or repeated.

As long as this condition lasts, nothing further can be recognized than that the stump of the iris has assumed a bulbous shape.

No sooner than several days after the operation, and when the coagulum has either been thrown off or absorbed, is it possible to demonstrate the following condition:

In the majority of cases the stump of the iris is either swollen—lying in the anterior chamber and rounded off—or obliquely cut.

In the first case, no wound surface can be discovered. The rounded surface is covered with epithelium, one-half of which is a part of the anterior, and the other a part of the posterior surface of the iris;* sometimes, however, the epithelium of the anterior or posterior surface covers the entire stump. These epithelial coatings are always in continuity with the epithelium of the iris. Where both coatings cover the stump, they generally meet in the centre and merge in each other. In the latter instance, it sometimes happens that, at the end of the stump, they are drawn like hooks into the parenchyma of the iris.

In some pigmented eyes, a hyaline-folded membrane is noticeable upon the epithelial layer, which covers the stump of the iris, and is filled with numerous minute molecules of pigment matter.

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* For the sake of brevity, we will call the layer of (pigmented) cells on the posterior face of the iris "Posterior Epithelium," although this definition would not hold good in the eye of the rabbit. (See Hampeln's Contribution.)

This membrane, which is only found on the apex of the stump, always inclines toward the anterior surface of the iris, and seems to extend, in some places, over a small part of the "anterior epithelium."

The substance of the iris, which, during the first few days after the operation, is swollen and thickened, and permeated by wandering cells, soon clears up, showing no further signs of infiltration.

In the *second case*, if the iris is clipped off obliquely and extends into the anterior chamber, either the anterior or the posterior layer of epithelium will protrude into the chamber. The protruded epithelium makes a curve on the apex of the cut surface, and fuses itself gradually with the epithelial layer of the other surface. This does not occur, however, before six or eight days have elapsed, while in the cases described above, where we have a bulbous extremity, the wound is never without an epithelial covering, not even immediately after the operation.

The other structural changes are identical with those already described.

The changes which the blood-vessels had undergone could only be demonstrated in very few specimens. In these I found that the vessels terminated at the border of the wound in the shape of cones, the apices of which were short in the larger vessels, but long and tapering in the smaller ones.

If the ciliary body and the stump of the iris are incarcerated in the corneo-sclerotic wound, the cut surface of the iris can never be noticed. The swollen end of the iris, either in the shape of a club, or more or less angular, is covered with a continuous layer of epithelium almost as soon as the operation is completed (say seven hours after). This epithelium is derived, as in the first case, either from the anterior or posterior, or both, layers of the iris.

Recapitulating the results of these examinations, we find that iridectomy wounds heal up in two modes, essentially differing from each other. One of them is characterized by the fact that a free denuded surface is never met with, and that the remaining portion of the iris is covered with a layer of epithelial cells immediately after the operation; while, in the second case, a gradual extension of this layer can be traced over the denuded surface.

If I examine into the causes of these two healing processes, which to a certain degree represent the unions *per primam* and *secundam intentiones*, I cannot think otherwise than that the direction in which the incision is made is of paramount importance.

Let us imagine that the incision made by the scissors excises a wedge-shaped piece of the iris,* the apex of which is towards the parenchyma ; it can then be seen how the two "lateral flaps" come together, and are agglutinated by virtue of their elasticity and the retraction of the divided vessels. The feasibility of such a wedge-shaped excision may be shown on a soft body, which is surrounded by a dense elastic envelope (such as a rubber tube), which is cut by means of scissors. The assertion that the immediate adhesion is facilitated by the retraction of the blood-vessels seems altogether plausible, since Prof. J. Arnold has demonstrated the unusual thickness of the muscular coat of the vessels of the iris. Another evidence of this mode of union, *per primam intentionem*, is furnished by the specimens in which the two layers of epithelium are drawn in towards the parenchyma, like hooks. Furthermore, the coating of the whole stump, by the epithelial layers of *both* surfaces of the iris, which meet on the apex of the swollen stump, seems to support the views here advanced concerning the pathology of this, the first mode of healing.

If we imagine that in the second variety the iris is cut obliquely, so that a "lateral flap" is formed, which is covered either with the anterior or the posterior layer of epithelium, the explanation of the subsequent changes is likewise simple.

In this case, however, two sub-varieties of the healing process are distinguishable.

In the one, the union by second intention takes place while we observe the epithelium growing from the sharp edge of the obliquely-incised iris over the wounded surface, finally to meet the epithelium at the obtuse edges of the wound.

This process is only noticeable when the iris-stump projects clear into the anterior chamber ; when, on the other hand, it is incarcerated with the ciliary body in the corneo-scleral wound, we find the stump of the iris always covered with epithelium, which

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* In the meridional direction.

comes either from the anterior or the posterior layer. This fact is easily explained by the incarceration and subsequent pressure, which favors, in a mechanical way, the inversion of the one lateral flap, and its early agglutination.

Concerning the hyaline, corrugated, finely-pigmented membrane described above, which here and there covers the anterior epithelial layer, I could not demonstrate its continuity with any similar structure in the normal eye (for instance, the covering of the *corpus ciliare*).

In examining the relations of the blood-vessels, I was never able to discover anything which might be proof of the direct passage of the blood from the arteries into the veins, as described by EXNER. As a matter of course, the greatest caution must be exercised in all examinations as to the relations of the vessels, since mistakes are only too apt to occur, owing to the possibility that the incision may not have involved the ends, but rather some of the innumerable windings of the vessels of the iris, resulting in the most varied pictures. The conical termination of the blood-vessels mentioned above, seems to need no further explanation. I have noticed them in too small a number of microscopic specimens to feel justified in drawing from them any reliable conclusions.

To compare the conditions of the human eye with those found in animals, could not but enhance the interest of these investigations. The kindness of *Prof. O. Becker* enabled me to do this. The relations found were the same as those already mentioned, but I never succeeded in gaining any further information as to the termination of the blood-vessels, nor did I ever, in the eye of man, discover a hyaline membrane before the stump of the iris.

II.—*On Abnormal Healing Processes following Iridectomy.*

In order to describe the complicated alterations characterizing the so-called "abnormal healing process" of iridectomy wounds, particularly the incarceration of the iris in the cornea-sceral wound, it may be best to begin with recording the microscopic changes in their chronological order.

I have selected such specimens, in which the changes were

best pronounced. They may be regarded quasi as typical representations of the conditions to be found so many days after the operation.

Three hours after the operation (unpigmented eye).

The stump of the iris and the ciliary body are engaged in the cornea-scleral wound, bulging above the level of the cornea. They are covered, on their anterior surface, by a thick, dense layer of cellular elements, and their vessels are engorged with blood. This cellular covering is also noticed on the inner surface of the iris. A shallow space filled with fibrine, which encloses numerous migrated cells, is observable between the covering and the impacted ciliary body. The impacted portion of the ciliary body itself shows a considerable engorgement of its vessels, and its tissue is partially suffused with blood. The parts of the ciliary body not lying in the wound, present a normal appearance. Besides the increased number of cells, a marked swelling of the fixed corneal corpuscles is noticed near the lips of the wound.

The offsets and anastomoses of the corpuscles are unusually conspicuous.

The portion toward the centre of the cornea is more infiltrated with small round cells than the peripheric portion; the opposite condition is found concerning the changes of the fixed corneal corpuscles.

Descemet's membrane is detached, and folded near its transition into the *ligamentum pectinatum*, and numerous hemorrhages are between it and the cornea.

The fibres of the ligamentum pectinatum, and the adjacent sections of the ciliary ligament, are loosened, and partially separated by extravasated blood. The sclerotic also shows, at this point, an abnormal arrangement of its fibres and lamellæ, *i.e.*, they appear to run in the direction of the extravasation, and here and there to be stretched.

In some preparations the membrane of Descemet is drawn in toward the lips of the wound (*i.e.*, outward), and curved especially on the scleral side. But this is by no means a common appearance.

Seven hours after the operation (pigmented eye).

The iris stump and ciliary body lie in the wound. The topographical relations are the same as in the eye described above—three hours after operation. The incarcerated parts are covered both externally and internally with a cellular layer; between the inner layer and the incarcerated ciliary body is the same coagulated fibrine saturated with migratory cells.

The membrane of Descemet is partly turned outwards at its anterior portion behind the ciliary body, and partly separated from the ligamentum pectinatum, and turned inwards. Extravasations of blood can also be found at this point, as well as all the changes of tissue described above. The membrane of Descemet is detached so much from the iris by the extravasations lying between it and the ligamentum pectinatum, that it penetrates at right angles into that portion of the iris which is adjacent to the cornea or sclerotic. The suffusion with blood also extends backwards and into the ligamentum pectinatum.

The corneal edges of the wound are swollen and interspersed with wandering cells in such a way that the migration is greater toward the centre than at the periphery of the cornea. A few pigmented molecules are forced into the cornea in the direction of the nutritive canals.

Twelve hours after operating (pigmented eye).

The scleral conjunctiva is considerably swollen at its reflected portion, plicated, thickened, and permeated by new cells. In the wound above the level of the cornea, a prominent substance is noticeable, which is covered externally by a continuous layer of pus-corpuscles, and consists in the greater part of coagulated fibrine.

In addition to this substance, a portion of the iris and ciliary body lies in the part of the wound adjacent to the sclerotic. The edges of the corneal incision show a scant immigration of cells; the fixed corneal corpuscles are somewhat swollen. The membrane of Descemet is bent outwards like a hook on both sides, but this is most marked at the anterior end, and is accompanied with a distortion of the corneal tissue.

In one preparation the *zonala Zinii* was still noticeable as attached to the ciliary process, which was lying in the wound; the remaining portion of the anterior capsule of the lens was parallel to the posterior surface of the cornea, while the posterior capsule was bent upon itself posteriorly (external, centrifugal). See Fig. 2.

At the point of insertion of the membrane of Descemet into the *ligamentum pectinatum*, there is another large extravasation; the membrane is partly detached, and the fibres of the ligamentum pectinatum, as well as of the ligamentum ciliare. are loosened by the hemorrhages.

Nineteen hours after the operation (*unpigmented eye*).

The conjunctiva is folded in wave-like folds; its large meshes are closely packed with newly-immigrated cells. As the incision, with Graefe's knife, passed through the conjunctiva, a piece of that membrane, plicated, loosened and filled with wandering cells, is found near the lip of the wound nearest to the centre of the cornea, merging into the tissue of the cornea, which is similarly affected.

The stump of the iris and part of the ciliary body lie in the wound. The vessels of these parts are engorged, and the adjacent tissue is infiltrated with blood. The incarcerated parts themselves are permeated by a delicate network of coagulated fibrine, in which numerous wandering cells are embedded. The entire contents of the wound bulge over the surface of the cornea, and are covered by a thick layer of pus-corpuscles which, however, does not extend beyond the lips of the wound. These lips, particularly the one lying nearest to the cornea, are filled with wandering cells to such an extent that the number of the new cells exceeds that of the corneal corpuscles.

The membrane of Descemet is remarkably thin, and curved outward at the anterior corner of the wound; this, however, is not the case at the other end.

The tissue of the stump of the iris is so much swollen that it is impossible to distinguish it from the ciliary body.

Four days after the operation (*a*) (*unpigmented eye, injected*).

The conjunctiva shows the same changes, already mentioned. The iris-stump and ciliary body lie in the wound, but in this case the ends of the incarcerated parts are not bent outward toward the cornea, but inward, toward the sclerotic, and are, to all appearances, merged in it. Numerous anastomoses are found between their vessels, and those of the adjacent portion of the sclerotic, and, at the same time, numerous vessels branch out from the granulation tissue of the incarcerated parts toward the centre of the cornea.

This new granulation tissue consists of long, large, spindle-shaped cells, mixed with less numerous round cells. The vessels seem to have been newly formed, and show numerous branches extending into the surrounding tissue. Most of them did not resist the pressure exercised in the attempt to inject fluid into them.

The coagulum, which fills the remaining portions of the wound, is composed as that above described, and covered with the same layer of pus-corpuscles. In contra-distinction to the cases described before, we here see that the wandering cells are all collected in a broad zone at the anterior lip of the wound, adjacent to the cornea; at any rate, none could be found in any other part of the wound.

There is pannus of the cornea, the vessels of which all arise from the conjunctiva.

The membrane of Descemet is again bent forward at the anterior edge of the wound, and the adjoining tissue is lacerated. This curvature is also noticeable on the posterior edge.

In incisions parallel to the equator, there are vascular connections between the pannus, resp., the conjunctiva, and the ciliary body. These connections are found at the same spot, where, in other cases, there was parenchymatous hemorrhage behind the *ligamentum pectinatum* and the membrane of Descemet.

Four days after the operation (*b*) (*unpigmented eye, injected*).

The conjunctiva is very vascular, and filled with wandering cells.

The stump of the iris and the ciliary body are found in the wound. Some coagulum is between them, and a good deal of granulation tissue is seen, which, as already stated, is composed of long spindle cells, and a few round cells (wandering cells ?). The vessels of this tissue proliferate into the incarcerated parts, as also into the conjunctiva (Fig. 4). Externally, there is no more a coating of pus, but a continuous layer of spindle cells (granulation tissue) which has an epithelial covering similar to that of the cornea in the portion adjacent to the cornea.

Here we have also pannus of the cornea.

The membrane of Descemet is also bent, as already described. That portion which passes over into the *ligamentum pectinatum* is detached, and its fibres are disunited by the extravasated blood, which has not yet been absorbed. Here also we find a vascular connection between the sclerotic (conjunctiva) and the ciliary body.

In some few sections there is a distinct plexus of blood-vessels immediately below the layer of spindle cells, the greater part of which, in all probability, is newly formed. Near it the granulation tissue is particularly prominent. The same changes are found in circular equatorial sections. The plicated anterior capsule of the lens adheres to the ciliary body.

Five days after the operation (*unpigmented eye, injected*).

The stump of the iris and the ciliary body lie in the wound and show numerous and important anastomoses with the conjunctiva. There is a coagulum near them, colored by numerous blood-corpuscles. The same is no longer covered with pus-corpuscles, but with a layer of epithelial cells which, in some sections, proved continuous with that of the conjunctiva.

Conjunctiva, cornea and sclerotica refilled with wandering cells. The fibrous structure of the cornea is unusually pronounced.

The membrane of Descemet, at both extremities of the wound, has undergone the changes already described. The traces of parenchymatous hæmorrhage are found at its junction with the ligamentum pectinatum and new vessels between the sclerotic and the cornea.

Eight days after operating (pigmented eye, injected).

The conjunctiva, or rather the continuation of the conjunctival epithelium, now covers the whole wound, and is filled with innumerable granules of pigment. No other conspicuous changes. The new epithelium of the wound forms a moderately thick layer.

The stump of the iris and the ciliary body have grown together with the wound and are surrounded by granulation-tissue which unites them to the cornea, sclera, and conjunctiva. This tissue extends, in the interior of the eye, on the inner surface of the membrane of Descemet towards the centre of the cornea, and is filled with large and small heaps of pigment granules. Some of the numerous vessels arise from the newly healed parts, and some from the pannus of the cornea.

The borders of the wound present no other change than extensive infiltration of pigment cells along the nutritive canals.

The membrane of Descemet is as before.

In some sections the uninjured iris merely lies on the cornea, or its anterior surface is drawn into the corneal wound. In these cases it is always surrounded by a layer of granulation tissue, which is traversed by branches of blood-vessels between the pannus and iris.

Twelve days after the operation (unpigmented eye, injected).

The conjunctiva still contains wandering cells, although few in number.

The stump of the iris and the ciliary body are united to the wound by firm and dense granulation tissue, which can only be distinguished from the cornea by its brighter color.

The vascular connections between pannus, resp. conjunctiva, and the incarcerated parts are quite conspicuous.

The membrane of Descemet presents on its anterior border the changes already described. At its point of union with the ligamentum pectinatum it is loosened and lies folded up between the ciliary processes and the sclerotic.

Thirteen days after the operation (pigmented eye, injected).

All the changes already described are plainly noticed.

The pigment found in the cornea before, can now be traced nearer to the centre.

Fourteen days after the operation (unpigmented eye, injected).

The iris stump, ciliary ligament and ciliary processes lie in the wound, which is now completely covered with conjunctiva.

The ciliary processes are drawn outward to such an extent that the ciliary part of the retina begins immediately at the inner surface of the wound. The parts are firmly agglutinated and permeated by numerous vessels, running in all directions, showing anastomoses through all the parts involved in the operation. Vessels also extend to the neoplastic tissue on the inner surface of Descemet's membrane.

The undulating and œdematous membrane of Descemet lies entangled between the corneal tissue at the border of the wound and the granulation tissue.

The posterior layers of the sclerotic are suffused with blood, and hæmatoidine crystals in the lamina fusca may be followed up to the entrance of the optic nerve.

Fifteen days after the operation (unpigmented eye, injected).

The involved parts are all healed up. The granulation tissue is considerably contracted, and only visible as a thin zone around the iris and ciliary body.

The wound is entirely covered with epithelium, and greatly bulging. A dense network of vessels lies beneath the layer of epithelial cells.

The parts inclosed in the wound, together with their covering (granulation tissue and epithelium), are so much stretched that the iris, in some parts, can only be distinguished as a very narrow strip (see Figure 5). Where the ciliary body is drawn into the wound, its vessels are so distended as to form almost straight lines.

Twenty-two days after the operation (pigmented eye, injected).

The iris and ciliary body are enclosed in the wound and only separated from the covering tissue by a layer of granulations. Numerous pigment granules are imbedded in all the surrounding tissues (see Figure 6), all parts are united by numerous vessels.

The membrane of Descemet is wavy and enclosed between the cornea and vascularized granulation-tissue. Its cut-edge is turned outward, and distinctly impacted in the corneal tissue. The pigment has advanced quite far into the cornea. Behind the detached membrane of Descemet vascular connections are found between the sclera and the ciliary processes.

Twenty-eight hours after the operation (unpigmented eye, injected).

No further changes are noticeable.

The conclusions arrived at by the foregoing experiments are as follows:

A. Conjunctiva Bulbi.

After the operation the surface of the conjunctiva is always folded and bent.

This change ceases when all the inflammatory symptoms have disappeared. The conjunctival epithelium begins to proliferate, and covers the larger part of the wound. In one single instance I observed that this function was assumed by the corneal epithelium. But this was an exception, for, in the large majority of cases, the conjunctival epithelium proliferates until it fuses with that of the cornea. The corneal epithelium also shows a tendency to proliferate in the direction of the wound, but to so slight an extent that it never furnishes one-third of the epithelial covering of the wound.

The covering of the wound with epithelium is generally completed within a week, when a continuous epithelial layer is found over the cornea, the wound, and the conjunctiva.

In the parenchyma of the conjunctiva we discover, even three

hours after the operation, a profuse quantity of wandering cells. The fibres of the parenchyma are swollen and transparent, and the tissue presents the characteristic appearance of œdema. These conditions disappear at the end of the first week. During the second week, however, occasional wandering cells may be found in the conjunctival tissue.

If the operation is done on a pigmented eye the tissue of the conjunctiva also abounds in molecules of pigment.

B. The Parts Enclosed in the Wound; the Iris and the Ciliary Body.

If the iris, or the iris and ciliary body lie in the wound, they are always pushed forward by the intra-ocular pressure, so that the prolapsus iridis often protrudes several mm. over the level of the cornea. Within three hours after the operation this is already covered with a dense layer of pus-cells, both on its peripheric and central portions.

The vessels of the iris and ciliary body are evidently in the condition of passive congestion. They are dilated and densely filled, and the tissue surrounding them is, in many places, infiltrated with blood. This congestion is evidently due to the incarceration of the parts in the wound. The incarceration itself partly results from the intra-ocular pressure, and partly from the changed conditions of the corneo-scleral lips of the wound.

Between the various folds of the tissues, principally the ciliary body, as well as between this and the stump of the iris, there is always found a fibrinous, translucent, minute network of coagulated fibrine, whose meshes are densely filled with new cells.

The vascular congestion causes an œdematous swelling of all the tissues during the first days following the operation, in consequence of which it is often impossible to distinguish between the iris and the ciliary body.

These changes, just described, are uniformly found within three days after the operation. It is also certain that a new formation of vessels takes place at this time. I was able to demonstrate this fact by injections after the fourth day. Before that time, the vessels could not withstand the slightest pressure of the injected fluid, and gave way.

On the fourth day after the operation, all the parts involved contain new vessels, some of which are quite small and thin; the majority have bulbous branches and diverticles, which are so arranged as to exhibit a great tendency to form anastomoses between the different sets of vessels. The conjunctival vessels seem to be most inclined and suited for the proliferation of new branches, as the largest of the newly-formed vessels are derived from the conjunctival system.

After the lapse of a week, the anastomoses between the different parts are so numerous, that it is almost impossible to detect the point of origin of the new vessels.

On the fourth day, we also have a delicate granulation membrane which makes its appearance between the folds of the tissues primarily filled with coagulated fibrine, and on the surface of the prolapsed iris. The granulation tissue appears to thrive best in the neighborhood of the vessels, and consists of large spindle-cells, between which a few round cells are scattered. At first this tissue is rather lax and translucent. Gradually it unites all the parts involved in the operation, and proliferates on the inner side of the membrane of Descemet towards the center of the cornea. By degrees it becomes vascularized and denser, so that about the twelfth day it presents a tough, fibrillated membrane, greatly like the sclerotic.

Externally it is overspread, as already mentioned, by the newly developed epithelium. It is the same in pigmented eyes—the ocular conjunctiva being filled with detached pigment molecules, which are scattered among its fibres, sometimes singly, sometimes in larger or smaller clusters.

C. *The Incised Borders of the Cornea and Sclerotic.*

The lip of the cornea and its adjacent tissue are also considerably changed within three hours after the operation. Their substance is œdematous and loosened, so as to present a much larger diameter than in the normal condition. Besides this, it is filled with wandering cells.

The fixed corneal corpuscles are enlarged and they, as well as their anastomoses, are distinctly visible after coloring with an ordinary ammoniacal solution of carmine.

The incised border of the sclerotic, on the other hand, is not swollen or loosened, but more densely infiltrated with wandering cells than the corneal border.

The imbibition of the corneal corpuscles, which extends as far as the cornea appears opaque to the naked eye in the vicinity of the wound, is always noticed in the first days after the operation, but disappears in the course of four or five days, when the immigration of cells sets in.

Pannus of the cornea is almost always observed; its vessels at first arise from those of the conjunctiva, and pass along the superficial layers of the cornea. Later on, however, the anastomoses are so numerous that it is hard to tell whether or not other vessels are also concerned in the production of the pannus. It was impossible to determine when the pannus first began, owing to reasons already mentioned. At any rate, it exists on the fourth day in the most superficial layers of the cornea.

The introduction of pigment also affords some interest. This pigment is seen within seven hours after the operation in the orifices of the nutritive canals of the cornea. Though not so manifest, it is also found in the scleral lip of the wound. Moreover, these detached pigment-molecules do not only lie in the orifices of the canals and fissures, but are also in the process of passing into them. This transportation increases during the first eight to twelve days. At the end of the second week, occasionally even later, these pigment molecules appear to be fixed in the corneal tissue.

D. The Membrane of Descemet.

This membrane appears to participate in the inflammatory action, which sets in after the operation. It becomes swollen to almost double its usual diameter. Besides this, it shows a proliferation of the endothelium of the anterior chamber.

Another constant change consists in this, that the two ends of the incision are turned outwards into the wound.

This turning outwards, which, in many cases, particularly late in the process of healing, becomes an impaction into the cornea (not so often the sclerotic), appears to be some evidence that this membrane also has the tendency to turn outwards, *i.e.*, centrifugally. Although I have never seen an incurvation which

amounted to more than two-thirds of a spiral rotation, still this seems to me to be sufficient evidence that there is a peculiar tendency to this doubling-up on itself towards this side. This is the more remarkable, as I have in my collection a number of preparations of the capsule of the lens, in which there is an unmistakable turning outwards, that is, a centrifugal eversion of the anterior as well as posterior capsules.

After removal of the lens, the capsules, in following their natural elasticity, often turned centrifugally in six, or eight, or more spiral windings. In the case of the membrane of Descemet, such complete rolling upon itself is impossible, as the corneal and scleral tissue, with which the membrane is closely united, present too much resistance.

Later on, the membrane of Descemet winds from the border of the corneal wound in numerous tortuosities, pretty far toward the centre of the cornea.

Even though I have never seen this rolling of the membrane upon itself in the human eye, it does seem to me that the conditions found in the rabbit's eye might easily be transferred to that of man, as the micro-chemical as well as histological identity of hyaline membranes has already been proven. The bending outwards and winding of the membrane of Descemet are not infrequently seen in the human eye after iridectomy.

On the scleral side of the wound the membrane of Descemet as well as the ciliary body is, almost always, dragged forwards and outwards, or detached from its insertion at that point, where it merges into the ligamentum pectinatum. It is then either folded in waves, or compressed between the sclera and the ciliary body, which is dragged forwards. Here it always yields to the direct mechanical force rather than to its own elasticity. This is easily understood, as a fixed point is wanting. In other cases it is detached from the sclera as well as the cornea, at right angles. These different conditions are particularly caused by the relative size of the extravasations of blood, which are very often found at this spot. The hemorrhage arises from the canal of Fontana, behind the *ligamentum pectinatum*, or the anterior ciliary arteries, branches of which are found in this region. The extravasation does not only affect the membrane of Descemet, but, besides displacing the ligamentum pectinatum, often separates the fibres of

the ciliary muscles, and passes into the parenchyma of the ciliary body. Later on, we generally find at this spot numerous anastomoses between the vessels of the sclerotic and the corpus ciliare, at the point where the anterior ciliary artery passes through the sclerotic to reach the iris and ciliary body.

The hæmorrhage, which is the result of the laceration of the tissues, is of particular interest, because it may give a clue as to the appearance of panophthalmitis after iridectomy. I speak particularly of those cases in which one eye heals without any disturbance, while the other is lost by panophthalmitis, although both were operated on under the same circumstances, at the same time, and in the same manner. It is easily conceivable that such an intra-ocular hæmorrhage may give rise to a bad result, the more so if its presence be unsuspected. If it be possible to recognize or assume upon good ground the existence of such a hæmorrhage, it might be advisable to make a puncture of the globe, and in this way evacuate the extravasated blood. This proposition is supported by the unfortunate result of an iridectomy, which I experienced, and which will be more fully described further on.

It only remains for us to discuss a complication, resulting at times from an enclosure of the iris in the wound. I speak of ectasia of the wound.

The relations are changed, inasmuch, as in consequence of the increased intra-ocular pressure, not only the covering of the wound, but of all the parts affected by the operation, are put upon the stretch to such a degree that it is hardly possible to distinguish the one from the other. The accompanying illustration (see Fig. 5) will explain this more fully.

III.—*Description of an Eye, lost in consequence of Panophthalmitis, after Iridectomy.*

After the operation a number of secondary intra-ocular hæmorrhages occurred, which entirely filled the anterior chamber, and

were only absorbed a short time before the enucleation of the globe.

The operation of enucleation was performed twenty-eight days after the iridectomy.

As soon as the anterior chamber again contained a transparent fluid, iritis and a marked occlusion of the pupil were recognized. The cornea had lost its normal curvature; there was an ectasy of that organ, and a peripheral pannus. The globe was small and phthisical.

After the division of the globe, the following macroscopic condition was found:

The cornea, which, at the seat of the wound, appears to be drawn in considerably towards the axis of the globe, is considerably distended otherwise, so that the section made through the anterior chamber, instead of presenting the appearance of a segment of a circle, looks more like a rectangle with rounded angles.

The iris is thickened and wavy, and is firmly united with the parts beneath, above the pupil, and the coloboma.

A sanguinolent mass is situated at the pupil. Behind the iris, and in the direction of the entrance of the optic nerve, where the lens ought to be, there is a foreign substance, the nature of which can not be determined. On the side opposite the point of iridectomy there is a roundish coagulum, about half the size of the lens, which pushes the choroid before it on an acute angle. The coagulum itself has a striated appearance. The choroid, displaced as above-mentioned, almost touches the opposite side, and is only separated from it by a very thin layer of tissue. Just at this point a cord-like body, coming from the optic disc, inserts itself. This is the detached retina, surrounded by large cavities, filled with coagulated matter. The vitreous and the lens have disappeared altogether.

The results of the microscopic examinations are as follows:

The pannus is quite extensive, and extends into the deepest layers of the cornea. But externally it reaches further towards the centre of the cornea than internally. The conjunctiva and muscular tissue are drawn into the cornea-scleral wound, and enclose the remaining, hardly-recognizable portions of the iris, and the numerous folds and twists of the posterior capsule of the lens. These tissues, which are fused together by newly-formed

masses, present numerous anastomoses of vessels. They contain, furthermore, numerous crystals—hæmatoidine—the remains of former hemorrhages. The ciliary body is only partly recognizable by the peculiar arrangement of its vessels; the same condition is found on the opposite side, where, here and there, a vessel may be traced to the choroid or the iris. The swollen iris is markedly infiltrated. It is drawn inwards, in wave-like folds, towards the centre (of the pupil). The masses lying behind it are found to be the innumerable folds of the anterior or posterior capsule of the lens. Fragments of the lens, and a tough, resisting, granular tissue, which is highly vascularized, are found behind these folds of the capsule. Here also hæmatoidine is scattered broadcast. At that spot where the choroid is detached from the sclerotic, it is apparently divided into two layers, of which the inner (choriocapillaris?) runs inward, and the outer (venæ vorticosæ?) runs outward from the striated coagulum, which was mentioned above. While the inner layer projects towards the axis of the globe at an acute angle, the outer layer is in direct opposition with the sclerotic throughout its entire course. The diametrically opposite portion of the choroid is also separated from the sclerotic by a loose, vascular, fibrous tissue, in which numerous hæmatoidine crystals are found. The sclerotic is permeated by a greater number of vessels than is usually the case; besides this, there is no other change in this coat. The two sides of the detached retina are closely adherent by their inner surfaces, and it is impossible to recognize any nerve elements, only connective tissue can be distinguished. The dense cord passes anteriorly into the tough mass, in which the remains of the choroid, lens, capsule, and remnants of the lens can be found fused together. In the centre of these two layers of the retina, the retinal vessels pass forwards and unite in various ways with the partly newly-formed and partly preëxisting vessels, which are arranged in stellate order, in this conglomeration of tissues. Those masses, which fill the cavities between the detached retina and the choroid, are partly coagulated fibrine, in which the remains of the vitreous body can be detected, but are principally composed of long, spindle-shaped elements, which are so intimately connected with Müller's supporting fibres that they may be considered as proliferations of the same.

The absorption of the lens on one side, and the subsequent plication of the lens-capsule on the other, were due to the fact that, owing to the very peripheric incision, the prolapsed lens was mistaken for the vitreous humor, and partly removed. But this would hardly be a sufficient explanation for such a general inflammatory process as we have already observed. I am, therefore, inclined to attribute it principally to the parenchymatous hæmorrhage, which in this case must have been more profuse than usual. This is the more probable, as there are on all sides traces of a very extensive parenchymatous hæmorrhage, and as the layers of the choroid were widely separated by them as already mentioned.

Explanations of Plates XIII. and XIV.

Fig. 1. The eye depicted in this figure was enucleated three hours after the operation. The section is made through the termination of the corneo-scleral wound. The membrane of Descemet and the innermost layers of the cornea and sclerotic extend beyond the contents of the wound, which are composed of the iris, the ciliary body, and a blood-stained coagulum. All these parts are infiltrated with wandering cells. The contents of the wound are covered by a layer of pus-cells; the tissue of the ciliary body is hæmorrhagically infiltrated.

Fig. 2. The eye which this figure is meant to portray was extirpated twelve hours after the operation. The contents of the wound and the changes in the tissue are the same as those described above. The zonala Zinnii and the anterior and posterior lens-capsules, are adherent to the ciliary body. The latter is doubled up in a centrifugal direction. (See page 429.)

Fig. 3. Is taken from an eye which was removed a week after the operation. The enlarged iris stump and the cilary body are lying in the wound, both of which are covered by a newly-formed tissue, which is filled with pigment-molecules. The dichotomous lines, both externally and anteriorly, are pannus and newly-formed vessels. The pigment-corpuscles are forced into the cornea in the direction of the nutritive canals. The membrane of Descemet is folded, and bent outward at its ends.

Fig. 4. This eye was enucleated four days after the operation. Besides the changes already described, the proliferations of the

vessels of the cornea (in black tracings), the newly-formed tissue, and the sclerotic, are particularly well-marked. (See page 432).

Fig. 5. The eye represented by this illustration, was removed fifteen days after the operation. The wound and all its contents are considerably dilated, and the tissue put on the stretch, as already described.

The iris is only separated from the newly-formed tissue by a narrow bright zone. The dark lines are vessels.

Fig. 6. This represents an eye, in which the "abnormal" process of healing has terminated (22 days after the operation). The changes are all identical to those already described. The tortuosities and curvatures of the membrane of Descemet are particularly marked. The vessels are less distinct, the pigment molecules fixed in the neighboring corneal tissue.

The explanation of Fig. 7 has already been given. (See section III.)

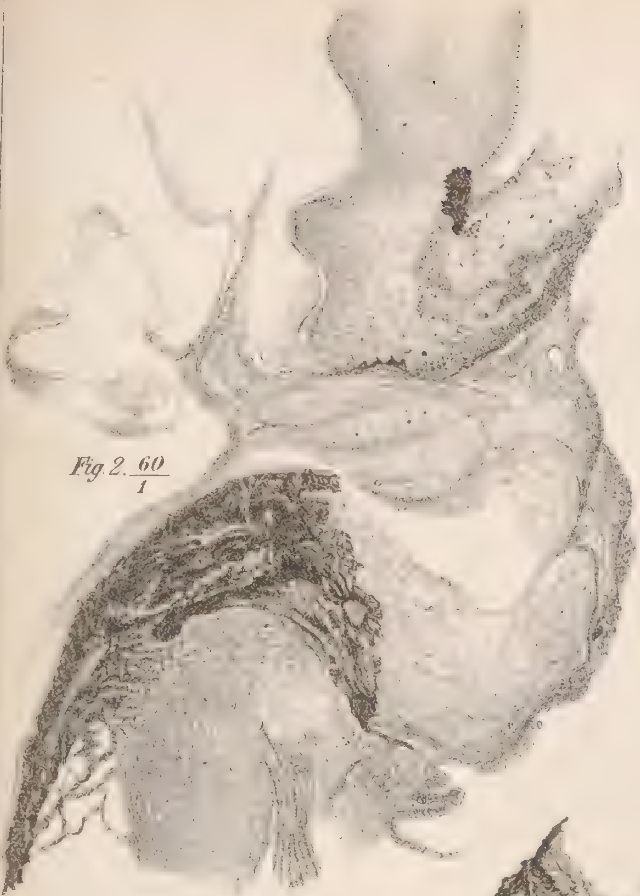

Fig. 2. $\frac{60}{1}$

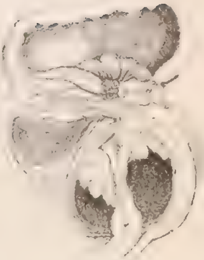

Fig. 7. $\frac{25}{1}$

Fig. 1. $\frac{60}{1}$

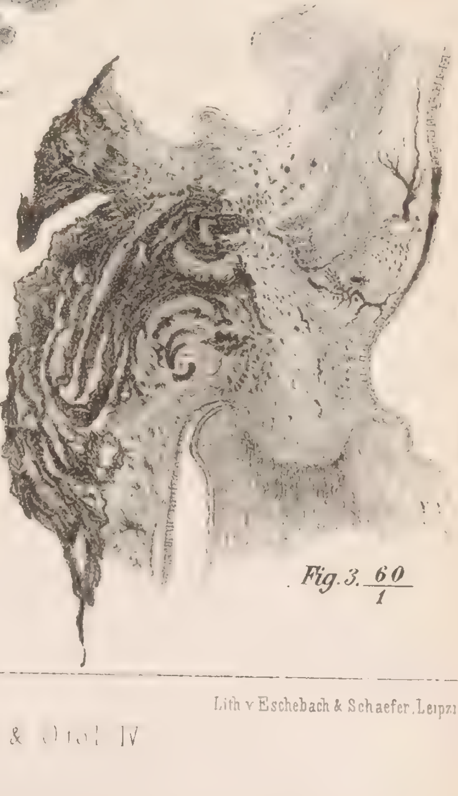

Fig. 3. $\frac{60}{1}$

Ad. Alt. del.

Lith. v. Eschebach & Schaefer, Leipzig

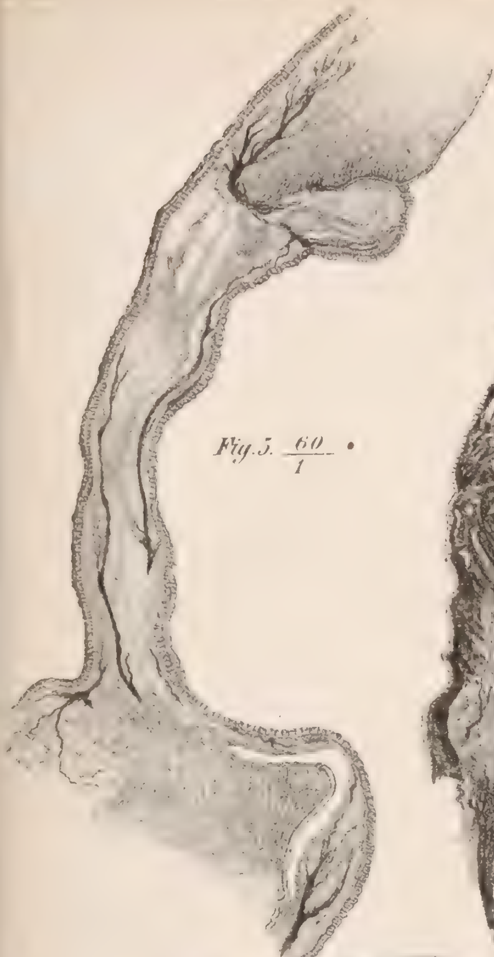

Fig. 3. $\frac{60}{1}$

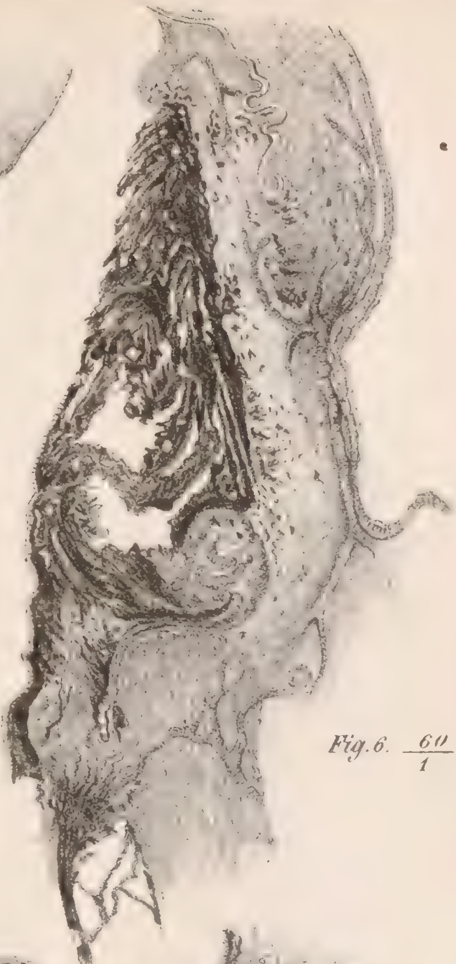

Fig. 6. $\frac{60}{1}$

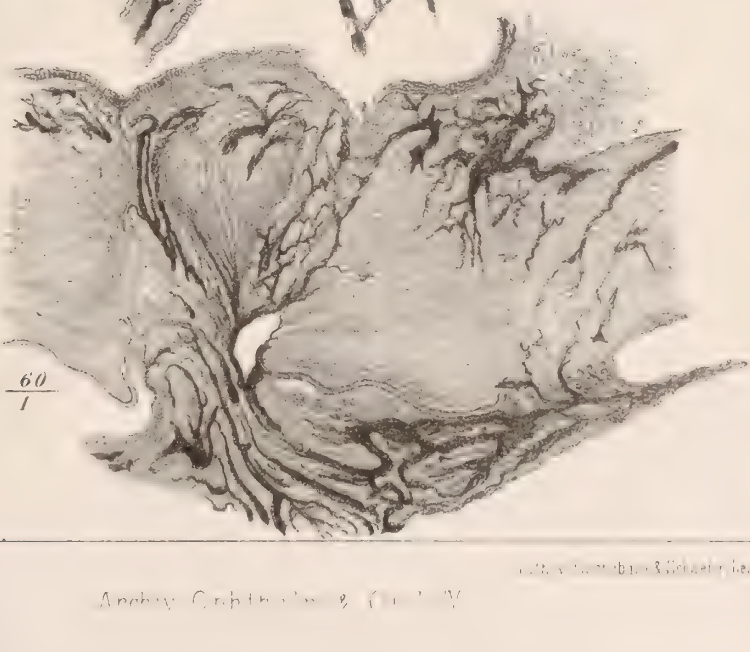

Fig. 4. $\frac{60}{1}$

DOUBLE-SIDED SIMPLE IRIDECTOMY, TERMINATING IN SLOUGHING OF THE CORNEA.

By H. KNAPP.

To see a simple iridectomy, performed correctly and without accident, in an apparently healthy eye, terminate in purulent iritis and sloughing of the cornea, is an event as unexpected as it is sad. Such a case, unfortunate in the highest degree, happened to me not long ago.

In May, 1875, a child, about a year old, of Jewish parentage, was brought to my clinic from the northwestern part of the State of New York. It was somewhat small for its age, but well formed and healthy-looking; had never been ill, and the parents, on their part, did not awaken any suspicion of a constitutional taint. The eyelids and eyeballs of the child were well developed. The size of the globes was not measured, yet no diminution was apparent. The pupils dilated moderately on instillation of atropine. In the centre of both lenses there was a dense whitish-gray opacity, of which irregular, short, and thin offsets extended into the cortical substance. I had, therefore, to deal with an irregular, probably congenital, nuclear cataract. The size of the lens did not seem diminished. The background of the eye could be uniformly illuminated; its details were not examined. The tension was normal. The movements of the eyes were not so prompt and direct as to warrant good vision, but the eyes followed the candle. The conditions were essentially the same in both eyes.

The central opacity of both lenses totally occupying the space visible behind the narrow pupil, and the nuclear cataract being either not progressive at all, or only very slowly progressive, I thought an operation was indicated, and preferred iridectomy to division.

The patient being etherized, I made on both eyes a small iridectomy down and inward. With a lance-shaped knife, the point and edge of which were faultless, I pierced the cornea at its transparent margin, directing the blade of the instrument at first toward the posterior pole of the lens, but as soon as its point came into view in the anterior chamber, parallelly to the plane of the iris, made a small wound, and withdrew the

knife in letting its point slide along the posterior surface of the cornea. The iris and the capsule of the lens were not touched. In one eye a small portion of the iris protruded; it was seized and abscinded. In the other eye I introduced the forceps into the anterior chamber as far as the lesser iris circle, seized the iris, drew it out, and cut it with one stroke of the scissors. In neither eye the anterior lip of the wound was injured. The artificial pupils were small, regular, and extended from the natural pupil to the visible periphery of the anterior chamber. There was no hemorrhage, the wounds closed perfectly, and everything looked as satisfactory as possible after a simple iridectomy, which had been free from accident. Both eyes were protected with a charpie and flannel bandage, and the child and its mother were admitted to the institution.

The operation had been made at four o'clock in the afternoon. The child was restless during the night. The next day the lint was wet and covered with a stripe of mucus corresponding to the palpebral fissure. The edges of the upper lids, and the inner canthi, were œdematous, the conjunctiva was injected, the wounds were closed, the anterior chambers reëstablished, their contents turbid, the pupils veiled, the irides discolored, *i.e.*, dull yellowish-green. I appreciated the danger at once, prescribed instillations of atropine every half hour, but abstained from any severe treatment, thinking that purulent iritis had already fairly set in. The next day all the inflammatory symptoms had aggravated, the cornea was whitish-opaque, the iris greenish-white, and the area of the pupil was occupied by a whitish-gray substance. The following day the whole cornea was white, the iris and pupil were no longer discernible. In the next two days both corneæ completetely sloughed, the irides bulged forward, and the total loss of both eyes was irrevocably declared.

What was the cause of this unfortunate termination? Neither the method of the operation, nor the manner in which it had been performed, could be blamed, since they differed in nothing from what we are used to do with impunity every day. Were the eyes of the patient unfit to be operated on? Irregular congenital cataract (I need hardly mention that I am not speaking of zonular cataract) is sometimes complicated with changes in the fundus of the eye and a certain degree of microphthalmus, but I have never hesitated to operate on such eyes, nor have I observed that the operations for them, *i.e.*, division, depression, and iridectomy, were followed by symptoms in any way severer than we encounter after the operations for ordinary cataract. Iridectomy, in par-

ticular, when performed on such eyes, is as innocent an operation as when performed on other eyes that are not inflamed. I will not enter into further discussions, but simply record this case as one of those very rare occurrences, in which a simple iridectomy is followed by purulent iritis and destruction of the eye. The occurrence of the same morbid process in both eyes makes us presuppose the existence of the same condition in both eyes, or of a constitutional predisposition. ARLT mentions * that out of 500 to 600 cases of correctly-performed iridectomy, one eye is lost. MOOREN † counted that among 240 iridectomies, one eye was destroyed by suppuration of the cornea, and VON GRAEFE ‡ met twice with suppuration of the cornea after simple iridectomy. In my own practice, during fifteen years, I remember only one more case in which both eyes were destroyed by suppurative inflammation after iridectomy; the case was that of an elderly lady, who had suffered, many years previously, from iritis, which had left extensive synechiæ, but her eyes had given her no trouble until, ultimately, chronic glaucoma had set in, and materially impaired her vision.

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* Operationslehre, p. 332, in Graefe-Samisch's Handbuch.

† Ophthalm. Beobachtungen, Berlin, 1867.

‡ Arch. f. Ophthal., xii., 1, p. 124.

BLINDNESS FROM ISCHÆMIA RETINÆ IN HOOPING-COUGH.

By H. KNAPP.

Blindness is a very rare symptom of hooping-cough. When, on the occasion of a case of that kind, I asked some of my New York colleagues about its occurrence, Prof. Loomis told me that blindness in hooping-cough had been observed, but almost exclusively in children, who afterward died from lobular pneumonia. According to that, blindness in hooping-cough would be an ominous symptom. Its cause and nature seem to be unknown. The case which came under my observation, threw some light upon the intra-ocular conditions of this affection, but, unfortunately, confirmed the remark of Dr. Loomis.

Toward the end of the winter of 1874 to 1875, Dr. D. M. Cory, of New York, kindly requested me to see a patient of his, an emaciated, highly-excitable boy of 3 years of age, who had been suffering from a severe hooping-cough for about six weeks. Two days previously, his parents had noticed that the boy, who formerly enjoyed excellent sight, and whose condition had not changed during the last week, complained of the darkness in his room, which was lighted as before, did not take hold of the objects around him as he used to do, in short, that he could not see any more. On examination I could confirm this fact. The eyes did not follow a candle-light, and the boy was unable to tell where the window was. Both pupils, however, responded promptly to changes of light. The eyes showed neither hyperæmia, nor ecchymoses, nor any abnormity. Their tension and mobility were normal. With the ophthalmoscope I found the media clear, the background luminous, no hemorrhages of any kind, but, on the contrary, the marked picture of *retinal ischæmia*. Both optic discs were white. In the left eye, only the main branches of the arteries were recognizable, and they were as thin as fine threads; in the right eye I could discern no arteries at all. The veins in both eyes were scant and thin, more so in the right than in the left. I thought that the ischæmia was possibly caused by a hemorrhagic effusion into the sheaths

of the optic nerves, or, more probably, by the general anæmia and the weak cardiac action of the reduced patient. Therapeutically I proposed nutritious diet, with some coffee and tea, and champagne diluted with water as a restorative beverage. If, within 24 hours, the condition of his eyes should not improve, I would suggest paracentesis of the anterior chamber, with the view that, by reduction of the extra-vascular pressure, the resistance in the retinal arteries be so diminished as to be overcome by the weakened propulsive force of the heart, which then would be sufficient again to throw blood into the retina. The affection, however, being an extraordinary one, I requested to be favored with the opinion and advice of the one or the other of my brother oculists. The little patient was then examined by Profs. NOYES and ROOSA, of this city, who both concurred in my view of the case. The child's condition having undergone no change during 24 hours, I performed paracentesis of both anterior chambers, kindly assisted by Drs. Cory and Noyes. The patient being etherized, the anterior chambers were almost totally emptied. The little operations were completed without any disturbance, in particular without procidence of iris into the small corneal wound, which was at a distance of about three millimeters from the margin. No symptoms of irritation ensued. The next day I found both pupils promptly responsive to light, and the retinal vessels better filled. Arteries had become visible in both eyes; the vessels were more numerous, and the optic discs less white than the day before. The patient had seen the light of the window several times after the operation, and had correctly pointed to the window. From day to day the retinal vessels became thicker and more numerous, and the optic discs less pale, without, however, attaining to the natural standard. The patient recognized the objects around him, and seized them correctly; for instance, of a number of apples he picked out the largest with a sure and direct grasp: sufficient evidence that he was no longer blind. A repetition of the paracentesis, therefore, was not indicated. His general disease, however, lingered between temporary improvements and aggravations, until about six weeks after the operation, he died from lobular pneumonia.

Disturbances of vision in hooping-cough, considering the frequent conjunctival ecchymoses, will naturally lead us to suspect intra-ocular hemorrhage. Nothing of this, however, was seen in the case just described. Though it is not justifiable to draw general conclusions from an isolated observation, yet the publication of the case under consideration does not seem to be without some value, as the reader may remember it on similar occasions.

The autopsy being refused, the question remained undecided whether the retinal ischæmia had to be referred to the reduction of the propulsive force of the heart, or to an effusion into the subvaginal cavity of the optic nerve pressing upon the nerve and the central retinal artery. The latter, less probable supposition I mention on account of the frequent external hemorrhages in hooping-cough. This alternative has no influence on the therapeutical problem. In the one as in the other case it is certainly rational to perform paracentesis of the anterior chamber, according to the principles laid down in the history of the case described above. These principles, to my mind, were first made known by ALFRED GRAEFE. The operation as such was successful in the above case, and, therefore, furnishes a valuable observation additional to the two cases of ischæmia retinæ, in which R. SECONDI and AUGUSTUS ROTHMUND performed paracentesis of the anterior chamber with good success. Once before I had an opportunity of making paracentesis of the anterior chamber for ischæmia retinæ in a boy of about 10 years of age, who had suffered for a longer time from excessive general anæmia, and had become blind two weeks previous to the operation. Though the pupils responded to light, and the evacuation of the anterior chamber was repeated several times, the vision did not return.

The subject of ischæmia retinæ still being a mooted question, the following *statement of the incident literature* will be of interest. I owe it to the kindness of Prof. Mauthner, the foregoing observations having been written at the bedside of my father, in a place where medical literature was inaccessible to me.

1861. ALFRED GRAEFE. Ischæmia Retinæ. *Graefe's Archives*, viii., 1, p. 143.—Iridectomy was successfully made on one eye; the other eye, after paracentesis had failed, was likewise cured by iridectomy.

1864. SECONDI, R. Caso di amaurosi per ischæmia della retina da atrofia di cuore, guarito colla paracentesi della camera anteriore.—*Turini.*

1865. HEDDÆUS. Ischæmia Retinæ, with secondary atrophy of the optic nerve; *Zeh. Klin. Monatsblätter.* 1865, p. 283.—Heddæus regrets not having performed iridectomy. Paracentesis was not made either. S. had recovered to $\frac{20}{40}$.

1866. ROTHMUND, A. Ischæmia Retinæ. *Ibidem*, p. 106. Two cases cured by paracentesis.

1866. V. GRAEFE. On Neuro-retinitis and certain cases of fulminant blindness. *Arch.*, xii., 2, p. 114, etc., p. 144: " In these cases (of ischæmia) a continuous circulation, as far as my experience goes, remaining obvious, I cannot account for the total abolition of the function by the sole fact that the supply of blood is limited which, the vessels being pervious, cannot be more than moderate. V. Graefe cites the integrity of the vision in the algid stage of cholera, in which there is ischæmia of the highest degree. He thinks that a bilateral retrobulbar neuritis is possible." In Alfred Graefe's case, slight alterations were not wanting, though, perhaps, disappearing, the margins of the optic discs being somewhat ill-defined.

1867. V. STELLWAG (3d edition of Text-book) advocates retrobulbar neuritis in such cases, but in the fourth edition, 1870, he explains them by a spasm of the blood-vessels.

1868. MAUTHNER, L. *Ophthalmoscopie. Wien*, p. 347. Literature. Secondi's case, unquestionably, is one of neuro-retinitis. In the case of Heddæus, with diminished frequency of the pulse, arterial pulsation, as in incipient syncope, is alleged to have been present.

Totally unexplainable is the existence of simple ischæmia, when (Rothmund) *the pulse is full*, and the sounds of the heart are normal. On the other hand, considering V. Graefe's opinion, the successful treatment of these cases by iridectomy and paracentesis is surprising.

THE STATISTICS OF THE OPERATIONS FOR CATARACT.

By Dr. J. HIRSCHBERG, of Berlin.

(Translated by Dr. G. W. Rachel, of New York.)

THE general recognition which Prof. *Von Graefe's* peripheral extraction of hard cataracts has met with in the course of a few years, seemed to denote a sort of final settlement as regards the experiences and convictions of oculists in this particular sphere of ophthalmic surgery. But numerous experiments made, and discussions held within the last two or three years, have rendered the result obtained doubtful again. In this regard there is a manifest difference between the first and the second third of the present century. Such an example as has been set by the elder *Sichel*—who repeated the flap extraction, as taught to him by *F. Jaeger*, a thousand times without any variation, because he had good results, but only added a good invention to it (viz., the compression-bandage), thereby reducing the number of losses by ⅓—will certainly become rarer in our days, where a curious eagerness governs our experimenters, so that they hasten from one modification of the operation to the other, some of which may be clearly put down as *retrograde steps*. Of course, nobody shall and nobody will be restrained from inventing and divulging real improvements.

But what position shall the practitioner take in the face of these oscillating endeavors, since he intends to treat his patients always according to the best method at his command, and has neither time nor inclination to try uncertain experiments? To this may be added that in extracting cataracts, an important condition of success is drill, which can only be attained by a frequent repetition of the same method.

Is there anything by the help of which correct (objective) judgment can be formed with regard to the value of operations for cataract? The recommendations with which every author accompanies the account of his method are more or less subjective impressions; they are too deeply founded in human nature to deserve of censure, but also too little reliable to exclude all doubt.

First of all, it cannot be denied that here, as well as in medicine in general, the *numerical method* is the only true basis for judging in this matter. The great merit of having first introduced this method into ophthalmology belongs to Prof. Rüte. Every author who tries to build up a new method without this foundation, has to take into consideration the fact that, no matter how excellent it is, its value is only subjective.

To declare various series of numbers to be doubtful, as has been lately attempted, is a dangerous procedure; it is even objectionable if the proof of incorrectness is not furnished. But it is quite another thing to establish the general value which a concrete series of numbers may rightly claim, and it is the *computation of probabilities* that furnishes us the necessary laws. It is to be greatly regretted that to this latter, which might be called the mathematical formula for common sense, little attention has been paid in professional statistics at large, as well as in our specialty. Yet, it teaches us above refutation that most of the different series of numbers published, because too short, do not establish with sufficient, *i.e.*, practically conclusive probability what they are intended to prove.

Now, as regards this objective mode of determining the value of a certain method of operation for cataract, the right plan has been floating before the mind of many authors. Some have even executed it tolerably well, as I shall show afterward by an example. I would like, however, to give the whole idea a more precise form.

It is evident that only that method of extraction can be designated as the best (relatively spoken) which gives

(1) The least number of lost eyes, and

(2) The highest number of visual acuity obtained.

It is better to foot up the losses than to add the results, because the former may be fixed unmistakably: just as the character of

an epidemic, *e.g.*, Asiatic cholera, is best determined by stating its mortality:

It would be necessary, therefore, to register the sum of all losses:

$$\Sigma(v) = \frac{p}{q},$$

where q represents all cases operated upon, and p the number of all the cases totally lost, and not to be improved by any after-operation; $\frac{p}{q}$ is a proper fraction generally of inconsiderable value (0.02 to 0.06).

Furthermore, the sum of the visual acuity has to be registered:

$$\Sigma(s) = \frac{a_1}{b_1} \cdot \frac{1}{s_1} + \frac{a_2}{b_1} \cdot \frac{1}{s_2} + \frac{a_3}{b_1} \cdot \frac{1}{s_3} + \quad . \quad . \quad . \quad . \quad . \quad . \; ;$$

where $\frac{1}{s_1}, \frac{1}{s_2}, \frac{1}{s_3}$ . . . represent the amount of visual acuity obtained, *e.g.*,

$$S = 1, \tfrac{3}{4}, \tfrac{1}{2}, \tfrac{1}{10}, \tfrac{1}{100} \; . \; . \; . \; \frac{1}{\infty}$$

(always *after* the necessary after-operations have been made), while $\frac{a_1}{b_1}$ stands for that quotient of the cases which have attained the sight $\frac{1}{s_1}$, etc.

This may also be written thus:

$$\Sigma(s) = \frac{\frac{a_1}{s_1} + \frac{a_2}{s_2} + \frac{a_3}{s_3} + \quad . \quad . \quad . \quad . \quad .}{b_1}$$

Since $b_1 \geqq a_1 + a_2 + a_3 + \quad . \quad . \quad . \quad . \quad . \quad .$ and since $\frac{1}{s_2}, \frac{1}{s_3}$, etc., are proper fractions $\left(\text{only possibly}: \frac{1}{s_1} = 1\right)$, it follows that $\Sigma(s)$ is always a proper fraction which, however, generally has a greater value than $\Sigma(v)$ (0.4 to 0.5), its ideal limit being 1. $\Sigma(s)$ represents at the same time the *mathematical* chance of an eye to be operated upon for cataract, since this chance has been defined as the product of the acuity of vision to be obtained (S = 1, $\frac{1}{2}$,

etc.), by the probability of the occurrence of such a result, or rather as the sum of these products.*

An example will elucidate this proposition. In "La Clinique Ophthalmologique du Dr. *de Wecker* par le Dr. *G. Martin* (Paris, 1873)," there was of 217 persons operated upon for cataract the sum of all the losses

$$[\Sigma(v)] = 7, \text{ or } 3.12\%.$$

The visual acuities obtained were :

1 in a single case.†		
$\frac{2}{3}$ "	58	cases.
$\frac{1}{2}$ "	49	"
$\frac{2}{5}$ "	69	"
$\frac{2}{7}$ "	17	"
$\frac{1}{10}$ "	10	"

$$\Sigma(s) = \tfrac{1}{217} \cdot 1 + \tfrac{58}{217} \cdot \tfrac{2}{3} + \tfrac{49}{217} \cdot \tfrac{1}{2} + \tfrac{69}{217} \cdot \tfrac{2}{5} + \tfrac{27}{217} \cdot \tfrac{2}{7} + \tfrac{10}{217} \cdot \tfrac{1}{10}$$
$$+ \tfrac{6}{217} \cdot \frac{1}{x} + \tfrac{7}{217} \cdot 0$$

$$= \frac{1 + 38\tfrac{2}{3} + 24\tfrac{1}{2} + 27\tfrac{3}{5} + 4\tfrac{6}{7} + 1}{217} + \ldots .$$

$$= \frac{97{,}6}{217} = 0.45 = \frac{45}{100}.$$

It must certainly be conceded that most statistics of these operations do not admit of a determination of the values of $\Sigma\ (v)$ and $\Sigma\ (s)$.

The numbers of operations in general are too small,‡ represent-

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* Secondary operations, in which, of course, a greater ability of the operator is required, admit only of the idea of so-called *moral chance* (*Espérance morale*, *Laplace*). $\Sigma = \left(\frac{1}{\sigma} + \frac{1}{s_1}\right)^{w_1} \times \left(\frac{1}{\sigma} + \frac{1}{s_2}\right)^{w_2} \cdots - \frac{1}{\sigma}$, where $\frac{1}{\sigma}$ represents the visual acuity after the principal operation, and $\frac{1}{s_1}$ the increase which may be expected with a probability $= w_1$, etc.

† There has been a mistake in this calculation, as *Geissler* has pointed out in "*Schmidt's* Jahrbücher": 222 + 6 + 7 = 235, *i.e.*, 18 more than were actually operated upon. I have taken the liberty of subtracting these 18 from the first series, as I want to give only an example of the method, not to establish definite values.

‡ It should not be attempted, as *Steffan* has done in his well-known paper, to make a long series by the addition of several short ones. The number of losses depends upon

ing fortuitous rather than real values of the quantities to be determined.

It is well known that skilful operators have made a considerable number of extractions without any loss, *e.g.*, *Graefe*, 113, and *Mooren*, 120.

But how small is the probability that such a record should chance to be repeated regularly?

Is it not a curious claim that has been put forth by some one, that 100 operations ought to give 100 good results?*

It is not necessary to dwell longer upon these facts, which are sustained by experience. I only wish to point out the teachings of the computation of probabilities in regard to longer series of observations, which already admit of being taken to account.

If only *two* events E and E_1 are possible, if n is the number of all the cases occurring, p the number of those which cause the event E, then the mathematical probability of E is:

$$w = \frac{p}{n}.$$

If not all the n cases can be observed, but only a limited number of them n_1, of which p_1 cases cause the event E (as established by observation), then an approximate value for w is:

$$w_1 = \frac{p_1}{n_1}$$

a value which is the more correct, the longer the series of observations n_1 (*Bernouilli*); of this value we can maintain with a certain degree of probability, arbitrarily assumed, that it differs from the true (abstract) value of w only by a fraction, which may be determined from p_1 and n_1.

(1) the method, (2) the skill of the operator, (3) the individual pre-disposition of the eye to be operated upon, and (4) various external circumstances. Two series, obtained by the same method, but under different external conditions, should not be blended together, except in case that both series are very long, so that the accidental variations, in regard to points 3 and 4, find compensation; and that there is justifiable reason to assume that the skill and precision of both operators are equal.

* If we would assume the probability of avoiding every small mistake to be $= \frac{19}{20}$, this probability for 100 cases would amount to $\left(\frac{19}{20}\right)^{100} = 0.0059 = \frac{59}{10000}$. Such minute mistakes are unavoidable; even more important mistakes may be committed in certain unfortunate cases, and by the most skilful operator. Should he have to operate upon an inordinate number of unfavorable cases, how could his results be unaffected by their detrimental influence?

If we choose (according to Poisson and Gavarret) the probability

$$0.995 = \frac{212}{213}$$

instead of the certainty (which = 1), then w will be found between:

$$\frac{p_1}{n_1} + \sqrt{\frac{8\,p_1\,(n_1 - p_1)}{n_1^{\,3}}}$$

and

$$\frac{p_1}{n_1} - \sqrt{\frac{8\,p_1\,(n_1 - p_1)}{n_1^{\,3}}};$$

which may be abbreviated to

$$w = a \pm \Delta a\,;\,^*$$

A. v. Graefe had in 900 cases of *flap extraction with compression bandage* 5.9% losses. The probability of a loss, while he operated after this method, was therefore between

$$0.05 + 0.02 = 0.07 \text{ and}$$
$$0.05 - 0.02 = 0.03.$$

It is therefore evident that the limits are here still pretty wide, if we are not satisfied with a lesser probability. But series of only 100 cases, with a loss of 5%, is too small for this degree of accuracy, as this would give

$$\Delta a = 0.06\,;\ i.e.,\ \Delta a > a\,!$$

A. v. Graefe furthermore lost in 600 cases of his own method 2.8%.

The probability of a loss while he was operating after this method, was therefore between

$$0.028 + 0.0191 = 0.0471 \text{ and}$$
$$0.028 - 0.0191 = 0.0089.$$

If the superior limit of the second series was *below* the inferior limit of the first series, it would be as good as certain that the modification of the method of operation would be the cause of the better result, since external circumstances, individual predispositions, and skill may be considered equal in both these long series.

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* The reader who has no text-book on mathematics at hand, may refer to "*A. Fick*, Med. Physik, 2d ed., p. 430, and to my book, being in press at this moment: Mathematische Grundlagen der Medicinischen Statistik. (Leipzig, Vas & Co.)

But since actually 0.0475 > 0.03, *i.e.*, the superior limit of the second series is *above* the inferior limit of the first series, we have to continue our calculation.

$$\text{If } \frac{p_1}{n_1} - \frac{p_2}{n_2} \geq \sqrt{\frac{8\,p_1(n_1 - p_1)}{p_1^{\,3}} + \frac{8\,p_2(n_2 - p_2)}{p_2^{\,3}}},$$

there is still a probability equal to $\frac{212}{213}$ that in the second series the additional circumstance (the modification of the method) was the actual cause of the different result.

But $$\frac{p_1}{n_1} - \frac{p_2}{n_2} = 0.05 - 0.028 = 0.022.$$

The value of the root = 0.0228 ; these numbers, therefore, furnish no efficient proof.

If we compare, however, the too longest series as yet published: 2,000 flap extractions with 10% loss (*Rivaud-Landrau*), and 1,500 linear extractions with 6% loss (*Mooren*), an analogous calculation will at once establish the superiority of *v. Graefe's* method.

This shows how long the series must be to give a decision of a certain value. [And even here we could only refer to the first criterion Σ (v)].

Not one of the latest methods has as yet furnished a sufficient number of facts so as to warrant a preference to *v. Graefe's* method. That the latter has also its *defects* has been lately explained in full by the well-known author who invented the Belgian method. I may here openly confess that his article (Annal. d'Oculist, LXXI., 1 and 2) was the cause that prompted me to write the present paper.

Iritis and iridocyclitis, even with sympathetic affection of the other eye, are well known to *v. Graefe* and his pupils as consecutive affections,* but with the means of preventing these rare accidents, they are no less familiar, viz., a less peripheral incision close to the corneal margin, and a most careful excision of the iris in the corners of the wound. For the present, I think it is greatly safer to cultivate the tried method of *v. Graefe* than to

* See the author's "Klin. Beobachtungen" (Wien, Braumüller), p. 35, note.

adopt new ones, in the wake of which may follow other and, perhaps, more numerous dangers.*

I may be allowed to conclude with the remark (which is not meant *pro domo*, however, since my former publications hardly touched on statistical ground):

Every one who underrates the value of scientific statistics in medicine, shows a limited understanding of the results of experience. He involuntarily substitutes to the *law* expressed by numbers his own opinion, which, though perhaps unprejudiced, must be unsteady, owing to the fluctuating condition of his mind and memory.

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* The request that came lately from Russia, as well as from America, that the Ophthalmological Society should hold a council and decide this question, ex cathedra, as a final settlement, is indeed to be taken as a sign of the times, but will, I hope, remain a pious wish.

OPHTHALMOLOGICAL REVIEW.

By E. GRUENING.

1. Talko, J. Zwei Fälle von congenitalem Coloboma palpebrarum. *Klin. Monatsbl.*, xiii., Mai und Juni, 1875, p. 279.

2. Talko, J. Choroidealspaltung des rechten Auges bei normaler Iris. *Klin. Monatsbl.*, xiii., Mai und Juni, 1875.

3. Stammeshaus, W. Ueber die Lage der Netzhautschale zur Brennfläche des dioptrischen Systems des menschlichen Auges. *Graefe's Archiv f. O.*, xx., 2, p. 147.

4. Bergmeister, Otto. Beiträge zur Beurtheilung der Aderhautentzündung und ihres Einflusses auf das Sehvermögen. *Graefe's Arch. f. O.*, xx., 2, p. 95.

5. Alexander, Dr. Ein Fall von Arachnitis mit Transport des Exsudates in den Bulbus. *Sitzungsbericht der Ophth. Gesellsch.*, 1874.

6. Dreschfeld, J. On a case of Sarcoma of the Iris. (*The London Lancet*, March, 1875, p. 140.)

7. Hirschberg, J. Ueber Verletzungen des Auges. (*Berl. Klin. Wochenschrift*, No. 22, 1875.)

8. Masselon, Dr. Clinique ophthalmologique du Dr. de Wecker. 1874. Opération du Kératocone, p. 19.

9. Wecker, L. de. Sur un nouveau procédé opératoire de la cataracte. (Extraction à lambeau periphérique.) Paris. Gauthiers-Villars, 1875.

1. Talko observed two cases of congenital coloboma of the lids. In a woman, aged 28, with a normally-formed eyeball, the inner half of the right upper lid exhibited two notches. One of these was situated directly over the pupil, the other nearer the inner angle. The notches seemed to be limited to the palpebral edge. On turning the lid it was discovered that they extended through the cartilage, dividing it into three sections without involving either the skin or the conjunctiva. The outer section was the largest, the middle the smallest. On the same lid, at a little distance above the notches, a small, hard, but elastic tumor was found. The surface of the tumor was covered with hair and connected with the inner notch by a ridge resembling a raphe. The tumor, a dermoid, had shown no tendency to grow, and had caused the woman no pain.

The second case, observed at the Ophthalmic Institute of Warsaw, showed more complicated congenital anomalies. The inner angle of the right eye of the patient, a young girl, appeared extremely large, because the cartilage of the lower lid ended at the inner corneal margin, and the lower punctum was much farther removed from the inner canthus than the normally-placed upper punctum. A fold of integument stretched from the lower punctum to the inner angle. A dermoid tumor of the size of a moderately-dilated pupil sprang from the inner and lower corneal margin. At the distance of one mm. above this tumor another growth of the same character, but of smaller size, was found. The pupil was neither central nor circular. It was displaced upward and inward, and bounded by latterly parallel bands of iris, such as are seen in congenital coloboma. In spite of the instillation of atropine, the pupil did not dilate.

2. A young and healthy man exhibited nystagmus of both eyes, and divergent strabismus of the right eye. Both corneæ were normal. The gray irides showed no trace of an embryonal split. The pupils were of ordinary size, color, and contractility. The sight had always been weak. (Patient could not read.) The visual field of both eyes was considerably contracted. Colors were imperfectly perceived. The ophthalmoscope discovered in the right eye a very extensive choroidal coloboma. The optic papilla had a pinkish hue, appeared somewhat notched (coloboma nervi optici?) in its lower portion (upright image), and was surrounded by a staphyloma posticum, below which, at a distance of one diameter of the papilla, the coloboma commenced measuring $3\frac{1}{2}$ diameters of the papilla in length and 4 in width. The anterior and lateral edges of the coloboma were strongly pigmented and connected with two grayish-white patches near the ciliary body. The surface of the coloboma was intensely white and shining.

3. St. investigated the refraction of emmetropic and ametropic eyes, and convinced himself of the fact that in the human eye the whole retinal curvature does not lie in the focal plane of the dioptric system. In order to determine the refraction of the various points of the retinal curvature, the author selected at first perfectly sound and apparently emmetropic eyes having a normal acuity of vision. He found that such eyes were only centrally emmetropic, and that at a distance of 5 diameters of the papilla they became somewhat abruptly hypermetropic, the hypermetropia amounting to at least $\frac{1}{15}$. The examination of hypermetropic eyes showed that the peripheral refraction differed only slightly from the central.

Hypermetropic eyes were found to be principally shortened in their antero-posterior diameter. In myopic eyes he discovered striking differ-

ences. In one case he found a central myopia of $\frac{1}{16}$, with a peripheric myopia of $\frac{1}{22}$; in another, a central myopia of $\frac{1}{7}$, with a peripheric hypermetropia of $\frac{1}{16}$. The latter condition St. explains by assuming that the eyeball had become distended in the antero-posterior direction, but had remained unaltered in the equatorial diameter.

4. The discrepancy between the ophthalmoscopic picture, and the degree of visual disturbance in choroidal processes, has called forth this attempt of B. of finding satisfactory points, enabling us to judge with the ophthalmoscope alone, of the degree of functional trouble in such processes.

He arrives at the following conclusions:

The common form of atrophic choroiditis, if limited to a middle zone, between the equator and the posterior pole, may run its course without causing a marked diminution of sight.

Choroidal foci approaching the papilla, may cause an impairment of sight, due both to the disturbance of the circulation within the optic nerve, and the turbidity of the posterior segment of the vitreous. If, however, a choroidal process extends forward beyond the equator, the diminution of sight depends upon the cloudiness of the anterior segment of the vitreous body.

Circumscribed exudations, as seen with the ophthalmoscope on the surface of the choroid, occasion scotomata, photopsia, chromopsia, and metamorphopsia. The degree of functional disturbance depends entirely upon the position of the inflammatory focus, especially its occurrence in the region of the yellow spot.

The sight is most intensely affected by those forms which produce, at the posterior pole, a dense, not easily absorbable, exudation, accompanied with a diffuse infiltration of the external retinal layers, and a general inflammation of the uveal tract. The optic nerve is at times seriously involved, and passes into a state of atrophic degeneration. Central vision may remain abolished, if the white and shining exudation at the posterior pole is not absorbed.

Pigmentation of the retina, in consequence of progressive choroidal atrophy advancing from the equatorial zone to the posterior pole, causes contraction of the field of vision and hemeralopia. Central vision remains intact for a long period, though the optic nerve may have assumed an atrophic appearance.

5. A.'s clinical observation is corroborative of the experimental investigations on the lymphatics of the eye, instituted by Schwalbe, Schmidt, Manz, and others.

A hitherto healthy child suffered from headache, accompanied with

vomiting, and lost the sight of both eyes within a few hours. A. examined the child shortly after the attack, and found vision totally extinct, the pupils dilated and immovable, the intra-ocular pressure normal, and the refractive media clear. The ophthalmoscope revealed peculiar and identical changes in both eyes. The red background had entirely disappeared, and was replaced by a bluish-gray layer, over which the retina was tensely stretched, with its arteries and veins somewhat dilated and distinctly visible in their minutest ramifications. The optic papilla looked hazy, but was clearly discernible by its outline and the convergence of the vessels. There were neither signs of retinitis nor of neuro-retinitis. The grayish mass behind the retina, in all probability an exudation, extended over every part of the fundus accessible to ophthalmoscopic examination. The child again enjoyed good general health. No further cerebral symptoms appeared. The temperature never exceeded 38° C. After four weeks the exudation began to absorb, and sight gradually returned. Two weeks later the mass had entirely disappeared. The retina looked somewhat atrophic, and the optic nerve pale. The sight was so far restored that the child could recognize small objects.

6. Sarcomatous tumors of the iris are rare. Hirschberg * regarded his specimen as unique. D. examined a spindle-celled sarcoma of the iris, and thinks that the mode of development of sarcoma of the iris may serve as a type of the growth of sarcomatous tumors in unstriped muscular tissue generally.

The patient, a lady 53 years of age, was first seen by Dr. David Little, December 20, 1871. She then presented hæmorrhage in the anterior chamber, which had taken place the night before. On January 6th, 1872, the blood had all been absorbed, except a very small portion on the iris below close to the corneal margin. Vision good. Fundus healthy. Repeated hæmorrhages occurred during the next two years, and when the eye was again examined in July, 1874, a tumor of the iris of the size of a split pea was discovered. The eye was painful, T + 2, anterior chamber half filled with blood.

Enucleation of the Eye by Dr. Little.—The mass filling the anterior chamber was found to be a small tumor, in section white, soft, and granular. It was bounded anteriorly by the cornea, to which it was firmly attached, posteriorly to the pigment layer of the iris, which it had left intact, inferiorly by the ligamentum pectinatum, which appeared also quite normal, while the superior border of the tumor was free. The ciliary body below was pushed back a little, and with it the lens,

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* Graefe, Archiv f. Ophthal., xiv., 3, p. 285.

the anterior and lower portion of which was opaque. All the other parts of the eye were normal. Microscopically, this tumor proved to be composed of closely-packed, spindle-shaped cells, and pigment masses of irregular shape and distribution. Thin sections at different regions of the tumor showed it to consist of two parts. The one, less transparent than the other, contained spindled cells, arranged in rows running in different directions, some vertical, some slanting, with hardly any intercellular substance; the other formed round or oblong islets, surrounded everywhere by spindle-cells, from which, however, they were separated by a layer of pigment masses. These islets proved to be cells of organic muscle, their rod-like nuclei, their size and general outline distinguishing them from the sarcoma elements. Besides these elements, there were small blood-vessels seen in all parts of the tumor, and pigment masses of irregular shape resisting all reagents. Where the tumor had abutted against the cornea, the microscope showed the disappearance of the posterior epithelial layer of the cornea, and a fatty degeneration of the latter, fat granules filling up the interior of the corneal corpuscles, and lying also free in the intra-lamellar spaces.

D. says that from the description of the specimen, it is more than probable that the tumor originated in nuclei, which appeared in the inter-muscular connective tissue, that these nuclei proliferated, became surrounded by a granular matrix, and eventually formed the spindle-cells. This view is furthermore supported by an observation of D. of a primary round-celled sarcoma in the muscular tissue of the heart, where the origin of the tumor would be distinctly traced to free nuclei appearing in the inter-muscular connective tissue.

7. J. Hirschberg describes, in a case of "Commotio Retinæ," an instructive example of that *ephemeral traumatic opacity of the retina* which, on account of its transitory nature, is but seldom observed, and hitherto has been described only by Dr. R. Berlin.

The right eye of a man, æt. 29, was struck by the end of a rope, and at once reduced to mere perception of light. Ten minutes later, he could distinguish with this eye the outlines of larger object. The following day he could read middle-sized print, and count fingers eccentrically in every direction. There was a wound in the scleral conjunctiva, surrounded by capillary hemorrhages; furthermore, circum-corneal injection, moderate mydriasis, and a minute rupture in the pupillary edge of the iris. Ophthalmoscopically, a *diffuse light-white opacity of the whole retina* was recognized, most marked near the optic disc, diminishing toward the periphery, and leaving the yellow spot free. The opacity was more intense than we usually find it in recent retinitis diffusa; the optic disc and

the retinal blood-vessels were unchanged. In the inner-upper region of the fundus there was a small, flat detachment of the retina, caused either by the wrinkling of this membrane or a thin sub-choroidal hæmorrhage. In the afternoon of the same day the detachment was no longer discernible, the retinal opacity had considerably cleared up, and completely disappeared three days after the injury.

The pupil, not yielding to atropia, remained moderately dilated, but caused no disturbance of accommodation. The tension of the globe was almost normal.

8. In a case of keratoconus, Dr. Wecker made abscission of the apex of the cone, and cauterized the wound with nitrate of silver twice during the week following the operation. At the end of the week he slit the ulcer transversely in the manner practiced by Saemisch. The wound was kept open twelve days, and then allowed to cicatrize.

The result was very satisfactory. Before the operation, the patient had M $\frac{1}{3\frac{1}{2}}$, S $= \frac{1}{10}$; after the operation, M $\frac{1}{10} = \frac{2}{5}$.

9. De Wecker devises a new operation for the extraction of cataract, and believes that he has found the ideal method.

He embodies his conception of a perfect operation in the following propositions:

1. The section should be placed in the best conditions of coaptation and cicatrization, and, consequently, be made through the sclero-corneal junction.

2. The section should allow of an easy and complete passage of the lens without necessitating the enlargement of the pupil.

3. Prolapse of the iris, a frequent occurrence in peripheral sections, should be avoided.

4. No attempt should be made to obtain certain advantages at the risk of a certain number of failures.

De W. describes his operation, which, as he claims, realizes all these desiderata, as follows:

First step. An assistant lifts the upper lid with the finger, or a holder. The operator holds the eyeball with a forceps near the inner corneal margin, and detaches the upper third of the cornea from its scleral junction. Thus a cornea of a diameter of 12 mm. will yield a flap 4 mm. in height, and measuring 11.32 mm. at its base. As soon as the counter-puncture is made, the fixation forceps is removed and the section completed without forming a conjunctival flap.

Second step. The eye is covered with a cold sponge a few moments. The operator holds the upper lid, introduces the ordinary cystitome, and lacerates the capsule.

Third step. The assistant takes again the upper lid. and the operator, while moving the lens towards the opening by means of the lower lid, at the same time depresses the upper lip of the wound, and the peripheral insertion of the iris with a hard rubber spatula, and thus disengages the lens.

Fourth step. The remains of the cortical substance are removed by gently rubbing the eye with the lower lid. Prolapsed iris is carefully pushed into the anterior chamber by the use of a spatula.

Fifth step. Instillation of a few drops of the neutral sulphate of physostigmine.

The action of the myotic shows itself after five minutes. The pupil becomes very small, and the iris loses all tendency to protrude.

No table of operations is appended.

OTOLOGICAL PART.

ON DEFECTIVE PERCEPTION OF CERTAIN CONSONANTS, COMBINED WITH A SIMILAR DEFECT AS REGARDS HIGH MUSICAL NOTES; WITH THE PHYSIOLOGICAL SIGNIFICANCE OF THE SAME.

By Prof. S. MOOS.*

(Translated by Dr. D. F. Lincoln, of Boston.)

These observations relate to defects in the perception of high musical tones, and of the so-called hissing sounds, especially that of S and the consonants related to it. Both descriptions of defective perception were observed at the same time in the same patient. The description of the disease in question will be given below. In some respects these observations form a continuation of the article published in the second fasciculus of the 2d volume of these Archives: "Pathological Observations upon the Physiological Significance of the higher Musical Tones." The cases given in the present article were instances of primary disease of the nervous apparatus of the hearing organ, originating in a great variety of causes.

The first patient heard the deep tones distinctly, as also the five first tones of the first octave; the tones from d^2 to g^2 weakly; above that point, no tone at all was heard. The patient recovered his powers of understanding speech very imperfectly, being able to hear very loud talking only at eight paces.

The second patient did not hear the low tones at all; he began to hear at f, and heard equally well from f to d^1; from the latter point they became more and more distinct. Hearing for speech, fifteen paces.

In the third case, the hearing of musical tones in general was weakened, and the hearing power was variable from time to time; when the latter was better for high tones, the power of understanding speech was also better, and *vice versa*.

* Lecture delivered before the Otological section of the Naturforscherversammlung, at Wiesbaden, Sept. 21, 1873.

In the fourth case, the power of understanding extended to only two feet, on both sides; the lower half of the musical scale was perceived, but to the upper half there was deafness on both sides.

The tests were made with a seven-octave pianoforte. The same is true of the cases now to be reported.

The cases of which I have just given a brief outline presented instances of primary affection of the nervous apparatus; but the same could not be supposed in the group of cases which is to follow, in which the histories seemed to show that the nervous apparatus was originally free, and did not become affected till later in a secondary manner.

I will now attempt to draw the features of this form of disease. The observations were made upon twelve persons, all of whom had received a musical education.

In none of the cases observed, was the duration less than four years; of very sluggish cases, where the hearing distance for words spoken aloud had fallen to three or four feet, and the power of perception for high musical tones had been lost from the third octave (inclusive) and upwards, there were some that had lasted twenty years and over.

The age varied from sixteen to fifty-three years.

The causes of the complaint were variously stated as colds, or typhus, and sometimes an hereditary predisposition to diseases of the ear was evident. Often no cause at all could be discovered. The affection had developed imperceptibly, so that even its duration could not be established with certainty. The progress was slow, as a rule, with a rate of increase that varied at different times.

Pain and discharge were denied in all the cases. But in no instance were the subjective perceptions of sound absent. As a rule they were bilateral—at least, if the disease had reached both ears, and their quality was exceedingly various; but they were always continuous.

Besides great dryness, there was no special anomaly to notice in the external meatus. Nor could any alterations be pointed out in the tympanic membrane, which could have explained even a part of the disturbances of function which are to be described; such alterations were of a subordinate character, and by comparing them with the total of the other physical symptoms, nothing

more could be done than to infer at most the character of the anatomical disturbance.

The position and curvature of the tympanic membrane presented little that was irregular, but its mobility was diminished in all cases. The inspection of the membrane, practised while the air of the outer meatus was rarefied, showed that the handle of the malleus, and the membrane itself, made smaller excursions and was less complete in its movements than would normally be the case. But the mobility of the handle or of the several regions of the membrane was never quite lost. In the majority of cases, a greater or less degree of hyperæmia of the handle was present, but this was wholly absent on both sides in two cases.

In many cases the mucous membrane of the tympanic membrane was decidedly cloudy, in whole or in part. Sometimes it was normal. The tuba Eustachii was permeable in all cases, by all the various methods of injection of air. During the performance of this operation, auscultation showed distinctly that the air was entering with a more or less strong impulse-sound. There were never any crepitant sounds, and free exudation in the tympanic cavity could not be found in any case. But the cavity, when the catheter was used and air injected, exhibited a diminution of sensibility in some cases and in others a total loss, although auscultation gave certain proof of the entrance of air into the tympanum, and of its striking against the membrane.

From this general statement of symptoms it follows, that the observations were made upon cases such as have previously been classified as "chronic catarrh of the tympanic cavity." I will not deny that they may, perhaps, all have been characterized for a period, at the beginning of the trouble, by the presence of free secretion in the tympanic cavity, but at the period of my observations they were no longer so characterized. At this time there was probably a chronic interstitial inflammation of the connective tissue of the mucous coat of the tympanic cavity and of the enveloping membrane of the inter-ossicular articulations. From my observations there are excluded—

1. Cases that are complicated with affections of the tuba Eustachii.

2. Cases of retraction of the tendon of the m. tensor tympani, and anomalous position of the handle of the malleus.

3. Adhesions of the tympanic membrane.

4. Cases of anomalous development of the posterior fold of the membrana tympani, causing anomalies in the tension of the membrane.

5. The so-called hypertrophizing form of chronic catarrh of the middle-ear.

Results of the Tests of Function.

Conduction through the air.—The maximum hearing-distance for the watch (the normal distance = 30 feet) was 15 inches; the minimum, zero. For words pronounced aloud, 10 paces the maximum, 1 or 2 paces the minimum.

The perception of musical notes was tested by the pianoforte. The patient stood in a chamber which communicated by a half-open door with the one in which the instrument stood, and about twelve paces from the latter. If tones were not heard at this distance, I caused the patient to approach the piano by degrees. The imperfections of the method must be admitted, yet it gave me valuable results. I had not König's steel rods at my disposal.

We shall further see that a piano of seven octaves is not sufficient to demonstrate the very first appearance of the functional disturbance.

In general, it appears that in the form of disease above carefully described, the power of perceiving high musical notes is disturbed. This disturbance begins with extinction of perception of the highest tones, and makes progress in the downward direction. I have not observed it to go below the C^3, or the whole of the third octave, in any case where any power of hearing speech remains.

Conduction through the bones.—This was wanting in every case without exception, for a cylinder watch that could be heard at six feet. For one that could be heard thirty feet it was often wanting, or the sound was heard but faintly from the temple, or was heard if held between the teeth, but not from the mastoid process and the vertex. If one ear was stopped while the watch was held between the teeth, it was regularly heard by the ear which was stopped, even if it had not been heard previously. The

forks $c^{I.}$, $c^{II.}$, and a were heard distinctly in all cases, without exception, through the air, when held near the ear; when applied to the temple they gave the following results:

As a rule, the patients declared that they heard the tone, but they never could say in which ear they heard it, even in cases in which the hearing of speech, of the watch, and of high notes was quite unequal on the two sides, so that the functional disturbance was unequal.*

Yet, as soon as either ear was closed, the tuning-forks were heard from the forehead in the ear which was closed. There was, therefore, in the case of conduction through the bones, a diminution in the power of hearing musical notes and the sound of the watch.

A peculiar functional disturbance, which has not yet been pointed out, as far as I am aware, in this disease, consists in a great difficulty, or even an absolute incapacity, experienced by all the patients in understanding the hissing sounds *s*, *ss*, *sch*, *z*, *c*, and the English tongue-aspirate *th*. It was found upon closer examination, that a sort of graduation might be made of these defects in perception, dependent on the following points:

1. Whether the hissing sound stands at the beginning or the end of a word or a syllable; or

2. Whether it occurs singly or doubled; that, therefore, the greater or less deficiency in perception depends further

3. Upon the *intensity* with which the hissing sound can be pronounced, depending upon its position in the word or syllable.

In respect to the *relative distinctness of perception* the following series may be established, derived from the results of tests of function:

1. Hissing sounds are heard most clearly at the beginning of a word, or when they occur double; in the first rank stands the initial sound Sch, and next the initial sound S: Schall, Schatz, Schiessen, Schmalz, Schrei, etc., Sonderbar, Sauerbrunnen, Säule, Stein, Stück, Sassaparill, Essen, Pressen, Vergessen, Circe, Citrone, Zirkel, Zumachen.

2. Less distinctly, the hissing sounds which occur at the commencement of a syllable but in the middle of a word: Zusam-

* The examination by the double otoscope confirmed the fact, that tones reached the ears of the patients unequally on the two sides.

menstellen, Ohrensausen, Widersacher. Mistakes occur here the S is often replaced by a consonant of lower pitch (especially when it makes sense), as D, for example.—"He behaved on that occasion *insolently*," was generally understood "*indolently*."

3. Still more indistinctly, the hissing sounds are heard at the *close* of words or syllables:

a. When they compose the *terminal consonant-sound, after vowels:* Haus, Ries, Weiss, Weismann, Gras, Sassafras, Graas, Rausch, Tausch. In these cases the hissing sound is either entirely dropped, or else is replaced by a consonant of lower pitch, as occurred in the previous series of experiments, especially when the substitution makes sense; thus the above words were heard as—Haut, Ried, Weit, Weidmann, Grad, Sassafra, Grau, Rau, Tau.

b. When they compose the *terminal consonant-sound, after consonants.* Here the penultimate sound is heard double, or the hissing sound is dropped, especially when this makes sense: pons, mons, fons, once, enfance, were understood as ponn, monn, fon, one, enfant.

4. The greatest difficulty is felt in the perception of the English tongue aspirate *th*, especially when it closes a word, and still more in the plural. In this case, *th* or *ths* is either not perceived at all, or the sound of *f* is heard instead. South, mouth, souths, mouths, are understood as souf, mouf; the word soothsayer sounds like soosayer, but is understood.

The question now occurs: What significance has this combined defect in the perception of the hissing sounds, and of the high musical notes, and how can we explain it upon physiological grounds?

Let us first make a somewhat closer analysis of a portion of the clinical symptoms.

We have seen that the patients, without exception, complain of subjective noises in the greatest variety, and that the conduction through the bones is much diminished or entirely lost. The majority of the present generation of aurists refer this phenomenon to an excess of intra-aural pressure, and I think rightly. Now we know from C. H. Burnett's investigations (in these Archives, Vol. II., No. 2, p. 45), that an increase of labyrinth-pressure beyond a certain point annihilates the physiological function

of the fenestra rotunda and the ossicula, and that, further, *the suspension of these physiological functions occurs sooner for high than for low notes.*

I have elsewhere shown that the higher tones are much more important for understanding speech than the lower; it remains here to explain why the deficient perception of the hissing sounds is one of the earliest and most striking symptoms—one may say, the most pregnant pathological symptom—in the case of our patients.

Wolf, in his work entitled "Sprache und Ohr," gives the pitch of S as $C^{IV.} = 2016$ vibrations, or $C^{V.} = 4032$ vibrations, according to the force of the stream of air; the S therefore corresponds to a very high tone; $C^{V.}$ is higher than the highest note of the seven-octave piano, for which reason the test by the piano may be inadequate for the very commencement of a functional disturbance.

This was made very plain to me by the examination of a certain patient, who had received a very thorough musical education. He complained of bilateral subjective sensations of sound, moderate in degree but continuous, with diminution of acuteness of hearing; the watch that should be heard at 30 feet was heard by him at 8 inches on both sides, and the conduction through the bones, on both sides, was weakened. No defect in the perception of tones was detected by the examination with the piano. Some weeks later he attended a concert, at which the Witches' Dance of Paganini was performed, in which a violin solo occurs, with many notes from the fifth octave. The patient, who sat about 15 paces from the soloist, was startled to find (as he assured me) that a great many high notes were not perceived at all; he could only tell, by the movements of the bow, that something was played. The fact that the absent hissing sounds are sometimes replaced by *d* or *f* is explained by the lower pitch of these consonants. According to Wolf the consonant *d* corresponds musically to about $fis^{II.}$, of which the pitch equals 720 vibrations; the consonant *f* to about $a^{II.}$, with 864 vibrations. It is possible that the same reason enables us to hear so well the sound of S combined with *ch* (= *sch*) at the beginning of a word. Wolf states that the latter corresponds to $a^{III.}$ nearly. Yet, as the closing sound of a word or a syllable, it is badly heard. The sharp and

the double S are therefore better understood, because they give rise to a double, rapid, and homogeneous excitation of the organ of hearing.

Conclusions.

1. One of the most important criteria for estimating the hearing power is the definition of the power of perceiving high musical notes.*

2. This criterion is decisive in regard to the prognosis of ear-affections.

3. Since the power to hear high musical notes is closely connected with the power of understanding human speech, it is necessary, in all cases of so-called progressive deafness, that the power of hearing high tones should be tested first of all. A case in which, after an interval of some months or a year, no further loss of perception in the downward direction of the scale is noticed, may be designated as *stationary;* all cases in which this is not true, as *progressive.*

4. One of the earliest symptoms of progressively increasing deafness is the defective perception of hissing sounds.

5. The treatment of such cases, of whatever sort it may be, can claim to be really successful only when the power of perceiving high notes is demonstrated to be more acute after such treatment than it was before.

As regards the matter of treatment, I will add, in closing, that I have made an opening in the posterior and upper quadrant of the tympanic membrane, on both sides, in four cases, making eight operations; this was done in the hope of increasing the power

* In the year 1868, Helmholtz informed me that he had been forced, by experiments which he had made with König's fine steel rods, to the conclusion that the normal power of perceiving high notes is different in different persons. It is known that many persons do not hear the chirping of the cricket. Dr. Blake,† of Boston, has very recently made a series of experiments with König's rods, and has shown that this graduated difference in the capacity for perceiving very high tones is in part related to the age of the individual.

† C. J. Blake. Summary of Results of Experiments on the Perception of high Musical Tones. Boston Medical and Surgical Journal, 1872, X., No. 20. In commenting upon the lecture delivered at Wiesbaden, before the Naturforscherversammlung, Prof. Schwartze remarked that Joh. Müller had already called attention to this difference in the power of perceiving high notes, as a phenomenon observed in normal conditions.

for perceiving high notes, a hope which I was fully justified in entertaining by the example and experience of Blake; but the attempt was not successful. In one case a violent purulent inflammation of the left middle-ear set in on the third day after the operation, lasting thirteen weeks, and giving me, perhaps, as much anxiety as it gave the patient pain. Perhaps future attempts in this direction may show better success, for I cannot doubt the accuracy of the statements made by Blake.

ON A CASE OF ENLARGEMENT OF THE BULBUS VENÆ JUGULARIS CEREBRALIS, AND ITS RELATION TO THE DEVELOPMENT OF HALLUCINATIONS OF HEARING.

By Prof. S. MOOS.*

(Translated by Dr. D. F. Lincoln, of Boston.)

It is known to you, gentlemen, through the demonstration made by Dr. Köppe,† that subjective perceptions of hearing may pass into delusions referring to hearing, which, involving as they do an altered condition of the brain, may form the starting point for the development of an actual mental disease. I do not feel quite satisfied in presenting to you the report of a single case, which after all only proves what has already been proved; especially as I never had the opportunity to make a personal examination during the life of the patient, but have been obliged to depend on the reports of colleagues, friends of mine, and fully to be trusted as observers. The fact, however, that I was permitted to make the post-mortem examination of both petrous bones, and the extremely rare condition of things which I found there, encouraged me to present the case before this Congress, for most of whose members it will possess very peculiar interest. The man whose case I shall describe was 64 years old at the time he committed suicide. He spent the last ten years of his life at Heidelberg and its vicinity, and was, I may almost say, known to everybody, even to transient dwellers in the city, as an original character, a peculiar person, going by the name of "Pöselmeier." He had gained this title by the numerous compositions, in prose and verse, oral and written, which he had been accustomed for many years to make, for the purpose of fighting against railroads,

* Lecture delivered at the Congress of Alienists in S. W. Germany, at Heppenheim, May 2, 1874.

† Gehörsstörungen und Psychosen. Allg. Zeitschrift f. Psychiatrie, 1867, Vol. 24, Heft 1.

steam-engines, factories, etc., which filled this world with such an intolerable din—he called it Gepösel or Höllenpösel—that his his head would scarcely bear it. He defended this position so obstinately as to acquire with many the reputation of being a fool. It is very probable that this noise in his head was subject to exacerbations and remissions ; for at times he would go into the fields, stop his ears tightly, and wrap his head up in a quantity of night-caps, and so forth, when he said he got some relief ; but in spite of his attempts to get away from the region of machinery, he admitted that the "hellish din" never quite left his head. This peculiar delusion was probably the reason why he had never been known to permit a physician to examine him. His hearing is said never to have been much impaired ; at least, such was never noticed to be the case in conversation. I doubt whether this was the fact during the last part of his life, for at the autopsy, among other things, we found that both meatuses were blocked with solid plugs. Beyond the limit of his delusion, he could not be called diseased in mind, in any respect, until the time when he committed suicide. He lived upon a small income, which he never exceeded by any form of extravagance. On the contrary, he used to sell his own poems ; had them printed in small editions, and succeeded in persuading people to buy them. And, although these flowers of poesy contained nothing in form or matter which will secure their transmission to posterity, yet they threw a peculiar light upon his psychical condition for the time ; for, taken in connection with the prose notes which he added, they prove that he always took an intelligent interest in the daily events, great and small, and in the important political occurrences between 1854 and 1870, and that his ideas upon these subjects were as liberal and enlightened as those of the majority of his contemporaries.

In the Crimean War he took the side of the Western powers, and celebrated their alliance in a poem. In the year 1859 he addressed a poem to the German Diet, exhorting it to become better and to proclaim freedom. In the year 1866 he was on the side of Prussia—he was by birth a Prussian—and from that time he was a zealous national-liberal, and in 1870 celebrated, in his poems, the victory of the Germans, and the glory of the German Emperor and Bismarck. For the rest, his poems are marked by a

thoroughly gay, one might almost say anacreontic, spirit; he liked best to sing the praises of friendship, love, and wine. Except for his hallucinations, he was very fond of conversation, and was never known to injure or insult anybody. Nearly a year ago, on the 28th of May, 1873, he put an end to his life at the Rose Tavern, in Kirchheim, where he had been spending a number of weeks. My colleague, Dr. Finck, found him on that day lying in a pool of blood, on the floor of his chamber in that house.

A cut, 15 centimetres in length, was found upon the throat, at the level of the thyroid cartilage, and another through the superficial flexor tendons of the left fore-arm.

When the wounds had been closed he said that he was obliged to kill himself; that that was no sin, for the noise of the machines could not be borne any longer. Death ensued on the next day. The autopsy, conducted by Prof. Knauff and Dr. Finck, was reported as follows: "Thin skull, with numerous osteophytes; membrane soft, extensively clouded, and thickened; much serum in the ventricles; cerebral sinuses normal; atheroma of the aorta, the arteria corporis callosi, and a. fossæ Sylvii, also in the line of closure of the bicuspid and tricuspid valves. In the lungs, hypostatic congestion and some emphysema. Heart enlarged, with much fatty deposit. Atrophied and fatty liver; trabeculæ of spleen thick; in the stomach was found a yellowish fluid; in the colon, firm scybala. Urinary bladder moderately full. In the pharynx, at the commencement of the œsophagus, was a valvular stenosis."

Having the opportunity to examine the petrous bones a very short time after death, I removed the labyrinths from both sides, treated them for 24 hours with a 1% solution of perosmic acid, and then, after removing the earthy substance, prepared sections. The result of microscopic examination was negative, for *there was found no alteration in the labyrinth.* The apparatus of the tympanic cavity was free from any important alteration; the mucous membrane on both sides had that appearance of saturation and cloudiness which is observed in persons of advanced age, even if their hearing has been good. The ossicula moved well in their articulations, and in other respects were normal, with the exception of the left incus, upon the body and the long process of which were found two extremely small exostoses; but these oc-

cupied a position where so slight alterations offer no obstacle to the transmission of the waves of sound.

In each external meatus there was a firm plug of cerumen.

The most striking change was found in the right petrous bone, on its lower surface, in the region which forms the floor of the tympanic cavity. The bulbus of the cerebral jugular vein lies in contact with this, in the normal state. The fossa, which receives the bulbus, forms a pit more or less shallow ; it never, under a normal condition of things, attains such an extravagant size as is the case in this preparation. In addition to the hollow which underlies the floor of the tympanum, and which of itself is well developed in this preparation, a cavity is formed by the jugular fossa, which extends through the petrous bone in almost every direction ; in height 2 ctm., in depth 1.8 ctm., and in breadth 8 mm. The lateral sinus presents no abnormality in point of size ; it is rather small than large. When the blood passed from it into the enlarged bulbus of the jugular vein, vortices must have been formed in the current during life, and in consequence, probably a very loud blood-murmur, which, on account of its closeness to the labyrinth, produced a continuous intensely loud subjective perception of sound, which the patient sought to explain in the peculiar manner above mentioned.

I will not try to decide whether a sound originating in this manner can be diagnosticated, during life, by the aid of the stethoscope. Beating noises in the ear, originating in the carotid, have been diagnosticated thus, and the diagnosis confirmed by finding that pressure on the carotid stopped the noises (Rayer, Politzer). If there should be a suspicion that dilatation of the bulbus venæ jugularis gave rise to the tinnitus, it would be proper to ascertain whether the intensity of the sound were not increased by compression of the vena jugularis cerebralis.

As regards the change in the condition of the brain, supposed by Köppe to exist, and which is required by the presence of psychical disturbance in cases like the present, this change might have been caused by atheromatous changes in the cerebral arteries, or by changes in the membranes of the brain, or by both taken together. I consider that no treatment can be of any use against such considerable anatomical alterations ; at least, nothing more than a palliative treatment, which should endeavor to pre-

vent or allay such exacerbations as originate in the vascular system, and which, to judge from the records, must have existed in the person of this patient.

Upon the close of the lecture, Prof. Friedreich remarked that Oppolzer had explained the tinnitus of chlorotic patients as an auto-perception of the *bruit de diable*, because it disappeared upon compression of the carotid ; he, Friedreich, had found this to be true in some cases, in others not. The lecturer then gave an account of a similar theory of Boudet's.* Boudet considers many cases of tinnitus to be produced by a conduction of the anæmic bellows-murmur in the vena jugularis, through the petrous bone to the auditory nerve. Just behind the bulb of the jugular vein lies the point of entrance of the lateral sinus, which is very narrow in comparison with the dilatation which immediately follows. In this place the bellows-murmur originates. In order to produce the murmur a certain rapidity of current beneath the contracted spot is requisite. Physiological and pathological conditions, which lessen this rapidity, prevented the occurrence of the noise. The diameter of the lateral sinus and of the bulbus of the jugular vein varied considerably within normal limits, and these variations were by themselves sufficient to explain why some persons had tinnitus only on one side, and why some had to suffer much more severely from this cause than others under the same circumstances.

The lecturer showed also a number of other petrous bones, which prove that the dimensions of the lateral sinus and the fossa jugularis ordinarily stand in tolerable proportion to each other ; he did not think that the theory of Boudet would explain the origin of the tinnitus in so many cases as the latter believed.

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* Compare Etude physiologique sur une variété de bourdonnement de l'oreille, placée sous la dépendance du courant sanguin dans la jugulaire. Jour. de la Physiol. V., page 39. (Jan. 1862.)

A CASE OF SARCOMA OF THE LEFT AUDITORY NERVE, WITH FATTY METAMORPHOSIS AND PARTIAL DESTRUCTION OF THE ORGAN OF CORTI.

By Prof. S. MOOS.

(Translated by Dr. D. F. Lincoln, of Boston.)

In medical literature there are to be found a number of observations of tumors of the auditory nerve, both at its central and at its peripheral end. Among the older cases may be mentioned those of Landifort,* and Lévêque-Lasource.†

Landifort found a small, hard, cartilaginous body six lines in length, which was united to the lower part of the auditory nerve, and that portion of the medulla oblongata which gives origin to the nerve. Lévêque-Lasource found, at the autopsy of an old woman, who had gradually grown deaf and blind, two ounces of serum in the lateral ventricles of the brain, the pituitary body much enlarged and ulcerated, and upon the left side a fibrous tumor of 14 lines in diameter, which occupied the base of the auditory passage.

Two more recent cases are given by Brückner ‡ and Bötticher.§ The last case I may presume to be known to the readers of the Archives. The case given by Brückner is that of his own wife, aged 28. The suspected cause of her disease was a very heavy fall on the back of her head on the ice, in her 13th year. The

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* Observations anat. pathol. Lugdun. Batav. 1777, Lib. I., cap. ix., page 116, sqq. Tab. viii., Fig. 5–7. f.—Museum anatomicum Lugdun. Batav. 1793, Vol. I., Sect. V., Nr. 3, pag. 232.

† Archives générales de médecine. Seconde Série. Tome vii., 1875. Avril, page 491. Both quotations are taken from Lincke's Handbuch der Ohrenheilkunde, Bd. I., p. 151–53.

‡ A Case of Tumor in the Cranial Cavity. Communicated by Dr. C. Brückner, in Ludwigslust.—Berlin. Klin. Wochenschrift, 1867, Nr. 29.

§ On the Changes occurring in the Retina and Labyrinth in a Case of Fibro-sarcoma of the Auditory Nerve, by Prof. Arthur Bötticher, in Dorpat. These Archives, Vol. III., part 1, p. 135.

first symptoms of the disease appeared about three years later, in the form of uncertainty in the use of her upper and lower limbs. Four years before her death a diminution of hearing upon the left side was accidentally noticed, with giddiness, and catarrh of the middle ear; and finally complete deafness.

At the beginning of the complaint there were subjective noises, which lasted as long as the phenomena of irritation continued, and afterwards completely disappeared; in the right ear there were sometimes, especially after excitement, singing noises that kept time with the pulse. Three or four months before death a whirring, like the placental murmur, could be heard by applying the ear directly to the patient's left temple; once, very eebly, on the right temple; this sound ceased to be heard by herself or others after she had used considerable quantities of iodide of potassium. The other symptoms were those of irritation and paralysis in the regions related to the nerves and portion of brain secondarily affected, the cerebral nerves from the fifth to the tenth, and the pons and medulla oblongata which were pressed upon and displaced. The left auditory nerve was absent at the autopsy; neither its exit from the brain nor its entrance into the auditory foramen could be demonstrated. There was a large glioma, which probably originated in the first instance from the auditory nerve itself. Catarrh of the middle ear was also present. The other nerves, from the sixth to the tenth, on the left side looked like thin threads, and could scarcely be recognized as nerves.

New formations, arising from the auditory nerve, within the internal auditory meatus have been observed by Förster * and Voltolini.†

In Förster's case a sarcoma of the size of a goose's egg sent out a process, shaped like a peg, quite deep into the left internal auditory meatus, which was considerably enlarged. In Voltolini's case a sarcoma filled the entire left internal auditory meatus; the auditory nerve was destroyed. According to Virchow, this nerve presents new formations oftener than any other cerebral nerve; he says that many such have been falsely described as neuromata.‡

The history of the following case, which I did not observe dur-

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* Würzburger Med. Zeitschrift, 1862, p. 199.

† Virchow's Archives, Vol. XVIII., case 2.

‡ Geschwulstlehre, II., p. 151.

ing life, is furnished by Professor N. Friedreich ; the opportunity to examine the preparation, by Professor Julius Arnold.

Regina Garrecht, cook, of Germersheim, æt. 49, was received March 25, 1871, in Friedreich's clinic.

The patient's family is healthy. She herself was well until her eighteenth year, when she went through a light attack of typhus fever. The menses appeared at the age of seventeen ; they were regular until their close, at the climacteric period, when she was forty-seven years old. Her present complaint is dated by her from August, 1870. At that time she slept by an open window, and awoke next morning with anæsthesia and a feeling of numbness of the left side of the face, as also numbness of the mucous membrane of the left half of the mouth, so that the tongue often got between the teeth in the act of chewing. Anæsthesia of the mucous membrane of the nares, with increased secretion, somewhat bloody. Then she consulted a physician for the first time, finding that her case was growing no better. She received electrical treatment three times a week for six weeks, but without benefit.

Very soon after the beginning of the anæsthesia, the left eye began to lose its power of sight, and the secretion of tears was increased. The patient was unable to read fine print. There was repeatedly a tearing sensation in the left upper eyelid, and a feeling of weight in it. The left lid drooped, as compared with the right. Moderate headache. Appetite good. Thirst increased. Tendency to constipation. Feeling of fatigue, and giddiness. Tongue little coated ; put out straight. Mouth straight. Temperature 37°, pulse 88.

March 26.—Temp. 36, pulse 72.

March 26.—Temp. 37.2, pulse 92. Headache less. To take Ol. Ricini.

March 27.—Temp. 37, pulse 60. Dizziness greater. Sleep tolerable. Stillicidium of tears has lessened. Power of vision is diminishing, so that the patient cannot thread a needle. Appetite good. Headache absent. Nasal secretion still abundant. Power of taste much diminished on the left side. No cough. Sensation alike in both sides of the occiput. Hearing worse on the left than on the right ; a common cylinder-watch is not heard on the left when applied directly, but on the right the perception is distinct at the distance of one foot. The watch is best heard (on the left) from the tuber frontale ; from the mastoid process not so well. In the left eye, a lateral limitation of the field of vision. Distant objects are sometimes seen double.

Internal organs present nothing abnormal. 37.0°; 92.

March 28.—37.0°; 68. Two stools. Sense of taste not much diminished on the left side; indifferent substances are not perceived so well as on the right, but substances like quinine, vinegar, etc., in dilute solution, are perceived almost equally well. The sense of smell has suffered very little on the left side. The mucous membrane of the left side of the nose is perfectly insensible when tested by the strongest mechanical irritations. Sensibility is weakened on the right. The same condition of the mucous membrane of the left half of the mouth and pharynx. Difficulty in deglutition is complained of. She often bites the left side of her mouth. When she blows with closed lips, air escapes from the left corner of the mouth. There is much dizziness in walking, especially after she has been resting for a considerable time; after she has walked awhile, her gait becomes steadier. It cannot be said that she is very insecure, or that her body totters, or is drawn toward one side, when she shuts her eyes.

Complete anæsthesia of the left cornea. Left pupil somewhat smaller than the right. Slight ptosis on the left. 36.6°; 72.

March 29.—36.8°; 72. Stools. The patient was somewhat more restless last night. Headache.

In the morning it seemed as if she were drawn slightly toward the left side when she walked. After sitting for some time, a good deal of dizziness. Pupil narrower on the left than on the right. Total anæsthesia of the cornea; even when it was touched with pointed objects, no reflex contractions occurred in the orbicularis muscle. Tearing pain in the left half of the face. The patient cannot tell whether her cheek is touched with a pointed or a blunt object; what is felt as pain on the right, is scarcely felt at all on the left side.

March 29.—36.6°; 72. Severe dizziness last evening. The difference in the pupils continues. Slight ptosis of the left upper lid, and slight twitchings in the orbicularis palpebrarum. Tearing pains in the left side of the face down to the chin. Twitchings of the levator anguli oris. No headache. In the evening the patient leaned toward the left side when she walked.

March 30.—37.0°; 76. Slept very well last night. Walks unsteadily this morning. Says that she walks with more certainty when her left eye is shut. Headache last evening. The anæsthesia of the mouth, the tongue, and the mucous membrane of the fauces, is very marked on the left side, but disappears close to the median line. The left glosso-palatine and pharyngo-palatine arches seem more flattened. Symptoms of double vision, when the eyes are fixed for a considerable time on rather distant objects, persist. Two stools. The patient feels very

tired, even after a short walk. Considerable twitchings in the region of the frontal, orbital, and some of the muscles of facial expression. Hearing is so weak on the left side that words, spoken in the ordinary tone of conversation, are merely heard but not understood.

March 31.—36.6°; 80. Slight nystagmus and twitching in the orbicularis palpebrarum. The difference in the pupils continues, and the left one is very narrow. While lying still in bed, the patient feels no dizziness. Gait unsteady in the morning. The body inclines to sway to the left. No headache. 36.7°; 80. Two stools. In general, no change.

April 1.—36.9°; 76; 36.8°; 88. Status idem. Sleep, at night, much interrupted. Again complains of symptoms of diplopia. The two images are seen side by side, and diplopia occurs only when single objects are fixed for a considerable time. No strabismus could be demonstrated. Double vision is accompanied by pain in the eye. Many objects look as if covered with a veil.

April 2.—36.8°; 76. Little sleep at night. Rather severe giddiness. No headache, except when she fixes her gaze on objects. Gait uncertain. Increasing weakness of the right eye. Ptosis commencing. One stool. Evening temp. 36.7°, pulse 80. Complains of very severe pain in the forehead, which lasted till morning, when a remission occurred. The coffee was vomited. Giddiness not increased. No diplopia today. The patient thinks she can lie more comfortably.

April 3.—Status idem. General condition good.

April 4 and 5.—35.6°; 80; 36.4°; 76; 36.8°; 72.

Ophthalmoscopic Examination: Large excavation; arterial vessels much contracted, veins considerably enlarged. Retina, as a whole, somewhat cloudy. Neighborhood of the papilla reddened. No pulsation. Giddiness greater; in other respects, status idem.

April 5.—Six loose stools, without disturbance of the appetite.

April 6.—Seton in the neck. Disturbances of vision, and dizziness unaltered. Slight lachrymation. Total anæsthesia of the left half of the tongue. Gait very unsteady.

Ophthalmoscopic Examination: Physiological excavation of both optic nerves; no other abnormal appearances in the fundus of the eyes. Left bulbus somewhat more resistent than the right. The disturbances of sight are considered as paresis of accommodation.

April 7.—36.4°; 104; 37.0°; 80. Nothing noteworthy.

April 8.—Gait unsteady. Body deviates decidedly to the right. Complains of pains in the eyes. The upper lids seem so heavy to the patient, that she often hardly keeps them open. Status idem.

April 9.—The anæsthesia is particularly marked at the middle of the

zygomatic arch, less so in the region of the lower jaw; in the cornea it remains as before. Considerable lachrymation of the left eye. No headache.

From the 10th to the 19th of April: Frequent diarrhœal discharges. Occasional double vision. Giddiness and severe headache. Fever; temperature rising to 39.4°; pulse between 80 and 116.

April 19.—Varioloid breaks out, and the patient is transferred to the hospital for small-pox.

April 28.—Patient is brought back to the medical clinic, in the same condition as before; during the month of May following, there is but little change. Diarrhœa continues, with a pulse rising to 116, and a temperature of 37° and 38°, with great weakness.

May 23.—The left eyelid is often in a condition of mimic spasm; in the intervals there is slight ptosis. Left side of face continues anæsthetic. The patient nevertheless feels light touches. Gait, tottering and uncertain. Weahness in left arm for some days. In combined movements, the hand makes inappropriate accessory motions and jerks.

May 24.—Permanent headache. 36.8°; 96; 36.6°; 104. Two stools.

May 25.—Feels well. 36.7°; 92; 37.2°; 100. Three stools.

From the 25th to the 28th, status idem. Only the power of sight has failed.

May 29.—The atactic motions of the left arm continue. The left frontal muscle is permanently contracted. Dizziness.

May 30.—Headache moderate. Four stools after a great error in diet.

June 1.—Double vision has returned after a short interval of suspension. Weakness so great as to prevent rising from bed.

June 3.—Double vision; the images over one another.

June 6.—Double vision. All the other symptoms seem permanent. Great hunger for several days past.

June 10.—Diarrhœa; on the 12th as many as sixteen stools.

June 13.—Dizziness. Double vision at times. Since yesterday the patient has a sensation as if the left side of the mouth were constantly burnt. Constipation.

June 14–19.—Diarrhœa again; on the 17th sixteen stools. Urine 1016. Giddiness and headache.

June 19.—36.8°; 104. Two stools. Giddiness so severe to-day that the patient almost fell over when going to stool.

June 19–21.—36.6° and 37.2°, 88–104. Headache. Dizziness. The patient complains of attacks of pain at the points of exit of the left trigeminus, and at the left mastoid process.

June 21–26.—36.2° to 37.2° ; pulse, 92 to 108 ; urine, 1012. Headache. Dizziness permanent. Diarrhœa sometimes profuse. On the 25th, severe headache, and once vomiting.

June 26–30.—Status idem.

July 1.—36.0°; 96 ; 37.0°; 100. Speech grows less distinct. The left eye is in the position of convergent strabismus.

July 2.—36.4° ; 88. The left arm now makes twitching (atactic) movements even when at rest. Dull frontal pain. Fluids swallowed often go the wrong way, and fluid almost always runs out of the left nostril ; much less often from the right.

July 2–16.—On the whole there is no change in symptoms, except that they are a little better or worse at times. Temp., 36.0° to 37.3° ; pulse, 76 to 112 ; sometimes diarrhœa.

July 16.—36.4°; 88 ; 36.6°; 92. Much headache and dizziness to-day. The patient feels " as if a ball were rolling round in her head."

July 16–19.—36.6° to 37.4° ; 100 to 132. The atactic movements in the left arm are increasing ; the speech is getting very indistinct.

July 20–24.—Varying severity of symptoms. Diarrhœa. 36.4° to 37.4° ; 84 to 116 for pulse.

July 24.—37.4°; 100. Two stools. The present condition of the patient is as follows : The subjective troubles consist of permanent headache and dizziness, more or less severe ; weakness of sight ; atactic movements of the left arm ; anæsthesia of the left half of the face, which is so great that the food and drink fall from the left side of the mouth ; the patient often swallows food " the wrong way," and fluids equally often are regurgitated from the mouth into the left (scarcely ever into the right) nasal cavity. The left side of the face and tongue, and the left eye, are less sensitive than the right, yet not quite anæsthetic. The left eye is in the position of convergent strabismus. The left frontalis is affected with permanent tonic spasm. The lower lid of the left eye makes frequent jerking movements towards the median line. The left arm makes atactic movements, but only under the influence of impulses of the will. In sleep, and when the patient's attention is called away from the arm, it lies quietly. The lower lip is pendulous on the left side.

Aug. 1.—The condition does not change. Temperature remained steadily below 37.5° ; the diarrhœa continued. The patient grew weaker and more broken. On the 11th of August, at 1 P.M., she received food from the nurse, swallowed it the wrong way, fell back with a rattle in her throat, turned black in the face, and died in a few minutes in spite of all that could be done. The finger applied to the epiglottis gave rise to no reflex act.

The *autopsy*, performed by Prof. J. Arnold, at 11 A.M., on the 12th of August, 1871, was reported as follows :

Rigor mortis slight ; integuments white ; subcutaneous cellular tissue poor in fat ; muscles pale ; skull compact, of medium thickness ; dura mater adherent to its inner surface, full of venous blood ; longitudinal sinus empty ; pia mater likewise moderately hyperæmic, and infiltrated with serum. Brain of normal size ; convolutions of normal appearance ; sulci very narrow ; both lateral ventricles are enlarged, and contain quite an amount of clear serum ; their ependyma exhibits some venous hyperæmia, but is delicate and transparent. The substance of the cerebral hemispheres and the great ganglia presents the conditions of moderate moisture, moderate amount of blood, normal consistency, and in no place any striking hardness or unusual softness. Outwards from the left internal auditory foramen, there is a tumor of the size of a walnut, of a roundish form, and in consistence unequal, being in one place harder and transparent, in another gelatinous and soft, like mucus. Its lower surface faces the dura-mater, its upper is turned towards the crura cerebelli, and is connected with them ; it pushes towards the median line, encountering the pons, which at this point is extremely flattened and very soft. The medulla oblongata, also, is dislocated towards the right, and the left lobe of the cerebellum is pressed aside, and distorted by the tumor. The auditory nerve of the left side seems to run through the midst of the tumor, and to lose its existence in the mass of the tumor ; both this nerve and the facial (which is flattened) are colored a peculiar gray. The internal auditory meatus is unusually wide in its inner portion. The left oculo-motorius is colored gray, and is atrophied through almost its whole extent. The fifth nerve of the left side is much flattened, and is also gray.

In the n. abducens, and the optic nerve of the left side, there is nothing of special interest to be shown.

In the cervical and dorsal portions of the cord there is quite an advanced degree of softening of the white substance, with moderate hyperæmia of the gray substance. Gray patches in the posterior columns.

I pass over the remaining details of the autopsy, adding only :

Anatomical Diagnosis.—Tumor of the left auditory nerve ; compression of the pons, cerebellum, left oculo-motorius, quintus, and facialis. Gray degeneration (secondary ?) of the spinal cord.

Old spots of broncho-pneumonia in both lungs.

Special description of the tumor, from an alcoholic preparation.

The peduncle of the tumor is formed by the auditory nerve, which can be followed from its origin to about the middle of the pedunculus cerebelli ad medullam oblongatam, but no further, because it there passes into the mass of the tumor, as above stated, where it loses its existence. The facial nerve is quite free, and has merely suffered severe compression. The tumor measures in diameter, both lengthwise and across, 3½ centimetres; in thickness, 2 centimetres. It is roundish as a whole, but its lower surface is pressed flat, and its upper is convex. It is covered by a thin membrane, like connective tissue, containing some blood-vessels, of about half a millimetre in diameter. Dissection shows the auditory nerve distinctly for two millimetres after entering the tumor, but beyond this point it can no longer be recognized by the naked eye, and has completely perished in the mass of tissue. The color of the tumor is entirely a yellowish white, broken only in the middle by a spot as large as a lentil, of a darker color, an appearance which was found by subsequent examination to be due to a considerable patch of ramified blood-vessels, crowded full of blood-corpuscles.

The consistence is quite hard; this fact must be partially due to the action of alcohol, since the report of the autopsy, already quoted, describes the tumor as "unequal, being in one place harder and transparent, in another gelatinous and soft like mucus."

Results of Microscopical Examination.

The tumor consists of spindle-shaped cells, and numerous, relatively broad vessels. The intercellular substance is but little developed, so that the spindle cells are altogether in excess. In most places they lie close together in large bundles, which cross in various directions. In the neighborhood of the blood-vessels the spindle cells show a complete concentric arrangement, surrounding the vessels like a sheath. The spindle-cells themselves have very long processes, and but a slender body. Where they lie less closely together, the spaces between them are full of cells, usually round, and containing one nucleus as a rule; in a few

places there are also single round nuclei, and, more frequently, longish oval nuclei, probably derived from the fragile body of the cells.

The Blood-Vessels of the Tumor.

These are very numerous, and of a pretty broad calibre. At the place above designated, as presenting to the naked eye a large dark spot, there were numerous close meshes, with broad ectasiæ, all crowded with blood-corpuscles. This spot was not free from slight extravasations, traces of which were found in granular pigment, pigment cells, and yellowish translucent cakes of the size of red blood-corpuscles (hæmoglobin ?). In the vessels which ran free, the endothelium could be plainly discovered.

Microscopically considered, therefore, the tumor is a spindle-cell sarcoma, which probably sprang from the elements of the connective tissue in the perineurium internum.

A second tumor was found in the internal auditory meatus. The latter was much enlarged ; the nerve was very thick, and on it was a knotty tumor as big as a good-sized pea, which closely filled the inner end of the foramen. The facial nerve is extremely thin, but its anastomoses with the auditory can be distinctly shown.

Microscopically, the second tumor has the same character as the first. As a point of pathological anatomy, we may assume that it originated from the first by the way of secondary infection.

The nervus vestibuli seems thicker than its neighbor the facialis. This thickening is, however, uniform. Microscopical examination shows that the nerve is attacked by secondary infection ; but that the process has not gone on to the same degree, since the cellular elements have not yet attained that excessive preponderance over the intercellular substance which existed in the other tumors. The portion of the facialis which runs through the petrous bone is also thinner than normal, and shows under the microscope a division and splitting up of the medulla of the nerve. In some of the primitive fibres the nuclei of the walls are seen very distinctly within the sheath. But we will lay no special weight upon these facts as indicative of degeneration of the nerve, because the preparations had lain a long time in alcohol before they were examined.

The cochlea presented a peculiar appearance. The membranous lamina spiralis of the first, second, and third turns was half gone ; where it was wanting, the canal was full of a yellowish atheromatous mass, composed microscopically of fatty detritus in a state of molecular degeneration, with a great many rhombic plates, crystals of cholesterin, which exhibited conclusively their characteristic reaction with sulphuric acid. In a few places only there were seen brownish, roundish cells, of various sizes, closely filled with very fine granules of fat, and rarely containing a nucleus, which may perhaps be regarded as derivatives of the former epithelial structures of the organ of Corti. As to the rest, there was nothing more to be seen of all the elements which are normally found in the ductus cochlearis.

That which remained of the lamina spiralis membranacea of the first, second, and third turn of the cochlea presented the following microscopical appearances : The teeth preserved their normal appearance at most places, but in some spots had lost their homogeneous look ; instead of the fine longitudinal striation, there were granules of fat arranged like rows of beads, or their appearance was quite light-colored ; at other places their surface was covered, especially towards their free extremity, by a finely granular detritus ; the cells which occupied the inter-dental grooves were also changed ; their nuclei were indistinct, and their entire contents were composed of finely granular fat ; the cell-membrane was mostly present. Inwards, both the teeth and the epithelial cells of the crista spiralis were unaltered. The membrane of Corti, as well as the basilar membrane, was altered quite in a similar manner ; they had lost their appearance of fine striation, and instead of this, there were seen extremely fine granules, standing in parallel rows like threads closely crowded together.

The arches of Corti and their heads had also lost their fine longitudinal striation in the same manner ; the epithelial cells in the region of the inner portion of the roof of the organ were enlarged, the nucleus mostly invisible, in most cases there was but a mass of fat-granules enclosed by the cell-wall, and in many cases the wall itself had perished by fatty degeneration, so that what had been cells was nothing more than heaps of granules, or else the granular detritus lay spread over the arches of Corti, and prevented their being seen.

In the alcoholic preparation of the structures of the vestibule I could not find any special change. The tensor tympani muscle was very thin, but possessed a fine microscopic striation. The mucous membrane of the tympanic cavity was thickened, the membrana tympani slightly drawn inwards, and much clouded at its periphery. All the ossicula were very imperfectly movable in their articular connections, and least movable of all was the connection between the stapes and the vestibule. The outer meatus was free.

Remarks.

Mechanical injuries * and syphilis † are known as causes of such tumors ; taking cold is only assigned as a suspected cause for their development. Virchow, in his celebrated work on "Morbid Tumors," states only mechanical injuries and syphilis. All the more remarkable appears the fact, that in the present case the first morbid symptoms appeared in the morning, directly after the patient had slept a whole night by an open window. It is true that, unless the patient neglected to notice the condition of her left ear (as is so often the case when one ear is healthy), the symptoms which first appeared did not relate to the auditory nerve on which the tumor was seated, but to the left trigeminus. The thought naturally occurs that the tumor, perhaps small in size, existed before the cold was taken, and that the latter cause only gave the first impulse to a considerable fluxion and consequent rapid growth in the tumor, already provided, as it was, with abundance of vessels ; from which period symptoms of pressure began to be noticed in the regions of nerves in the vicinity, particularly the trigeminus, and soon took a marked development, so as to give the patient the first information that she was really sick. This view is supported by the fact that, between the outbreak of the first symptoms (August, 1870,) and the occurrence of death (August, 1871), the interval of but a single year had elapsed ; and certainly the tumor was very large in proportion to this time, if we merely take into account the dimensions of the alcoholic specimen. On the

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* Brückner's Case and Kupferberg. Beitrag zur Pathol. Anatomie der Geschwülste im Verlauf der Nerven. Mainz, 1854.

† Aronssohn, Obs. sur les Tumeurs développées dans les Nerfs. Strasbourg, 1822.

whole, the symptoms developed not violently, but very gradually. If we consider the great dislocation of the pons, medulla oblongata, and left lobe of the cerebellum found at the autopsy, of which organs the two first must be regarded physiologically as very vitally important members of the central nervous system, we are obliged to assume a development of the tumor which was at first *latent*, and afterwards slow and gradual. For it is only in this way that the pons and medulla oblongata, together with the left cerebellum, could have endured such great dislocation.

The fluctuations in the symptoms—not on the whole very considerable ones—can be explained by fluctuations in vascular activity, such as the anatomical structure of the tumor greatly favored. If we consider that the left auditory nerve had perished in the mass of the tumor at its central end, and that a second tumor had developed through secondary infection in its peripheral end, and that the left trigeminus, oculo-motorius, and facialis underwent a pressure from the tumor during life, we shall find nothing strange in the clinical phenomena ; these changes explain the disturbance of hearing and sight, and those in the regions of the left facialis and of the trigeminus, the latter of which present a great analogy with the well-known symptoms of section of the trigeminus, except that ulceration of the cornea was absent.

The headache, dizziness, unsteadiness, and slight tottering in walking, are nothing strange ; the absence of actual phenomena of rotation is very remarkable, considering the pressure on the pons, which at last became permanent. So as to the sensation "of a ball rolling round in the head."

Especially remarkable is the fatty degeneration of the finer structures in the lamina spiralis membranacea of the cochlea, and the complete breaking down, in parts, into a molecular detritus ; nothing else could have been expected, considering the total loss of the nerve in the substance of the tumor. With this state of things the complete loss of the function of hearing corresponded.

The nervous connection being entirely suspended between the outer and the inner portions of the nerve, it seems natural that there should have been no subjective symptoms of hearing ; it is very remarkable, from this point of view, that the patient possessed the power of bony conduction for the sound of the watch to the left ear, during the first part of her stay in the hospital.

I therefore can only lament that I was not permitted to institute more exact tests of the function during life.

As stated above, the left tympanic cavity showed evidence of a slowly progressive inflammation of the mucous membrane, with a diminution of the mobility of the ossicula. It is scarcely possible that this condition of things could have been developed within the period of one year, and yet the patient never said that she had formerly had trouble with her left ear. Might not such cases, perhaps, depend on a tropho-neurotic disturbance in the middle ear, connected with the intra-cranial disease? In Brückner's case, mentioned at the beginning, there was also found on the body a chronic catarrh of the middle ear on the affected side, and the first time the hearing was noticed to be on the decline on the left side, the observation was made by chance. Further cases may perhaps, by and bye, explain to us what remains unexplained in this.

ANOTHER CASE OF FATTY METAMORPHOSIS OF THE ORGAN OF CORTI, DUE TO OTHER CAUSES THAN SARCOMA.

By Prof. S. MOOS.

(Translated by Dr. D. F. Lincoln, of Boston.)

I OWE the opportunity of examining the following case to the kindness of Prof. von Dusch; the autopsy was performed by Prof. Arnold.

K., æt. 75, pensioned ecclesiastic. The trouble in his ear dates from an attack of small-pox in his boyhood, followed by deafness, which compelled him to sit in the front seats both in the public school and in the lectures which he attended while a student at the University. This deafness gradually became total. About twelve years ago the patient was still able to play the piano correctly, provided he held between his teeth a stick of wood, the other end of which rested on the sounding-board of the instrument. For about ten years he has been completely deaf, and unable to play even in the manner described. For twenty years previous to that time, he had used a trumpet for the left ear, a rather heavy instrument, which by its constant pressure had produced an atrophy, sharply marked by a deep furrow, of the muscles between the thumb and forefinger on the extensor side of the left hand; the mark was distinct on the dead body. In the year 1867, K. had a slight attack of apoplexy with difficulty of speech and temporary disturbances in the motions of the extremities of the right side. On the 8th of January, 1873, symptoms of cerebral bleeding suddenly appeared, which brought the patient's life to a close on the 12th; the autopsy was performed on the 14th.

It must be added that K. had suffered from subjective perceptions of sound as long as he could remember. They must have been very severe, for in former years he often said to his friends: "If you could only guess a part of the frightfully tormenting noise and fury within my head, you would be amazed that a man can bear such pain, not for a short time but for many years, without harm." But during the latest years he said that these noises had grown "much weaker."

Autopsy.

Roof of cranium thick and compact. Dura mater firmly adherent to the inner surface of skull. Much dark blood in the longitudinal sinus. Upon the inner surface of the dura, especially on the left side, several hard white masses. with a granular surface, about as large as a groschen, intimately connected with the dura (Psammomata). Diffuse cloudiness of the pia. Convolutions of brain much flattened, more so on the left than on the right. The left lateral ventricle considerably dilated and full of blood, partly fluid, and partly coagulated.

The anterior segments of the thalamus, and the posterior part of the corpus striatum, were completely disintegrated in their peripheral parts, while the adjoining layers of brain were tinged red by imbibition and very soft.

The right lateral ventricle contained fluid blood. The third ventricle was entirely filled with clots of blood, as were the aquæductus and the fourth ventricle. The choroid plexuses were studded with grains like sand, so was the arachnoid over the pons. The vessels on the base of the brain all showed a state of extreme chronic endo-arteritis.* Heart and aorta normal. At the apex of both lungs were bronchi-ectasiæ filled with cheesy masses, and remains of old broncho-pneumonic disease.

Anatomical Diagnosis :—Encephalohæmorrhagia, chronic endo-arteritis. chronic pachymeningitis externa and formation of psammomata upon the inner surface of the dura mater and on the plexus choroides.

The temporal bones, examined without the tubæ, presented the following appearances : Dura mater upon the surface of both bones, much injected and hard to remove. The sheaths of the two facial and optic nerves in the porus acusticus internus, greatly injected. In the external meatuses, which were very wide, nothing remarkable. Vessels of the handle of malleus. in both ears abundantly injected. In both tympanic membranes, towards the anterior part a depression like a funnel and quite deep ; the centre of both membranes was very transparent, but the periphery, especially at the posterior part, was very opaque, in consequence of peripheral opacity of the mucous membrane at the edge. The capacity of the right tympanic cavity was very small ; its floor was traversed by zigzag bony ridges, about $1\frac{1}{2}$ mm. high. From the posterior part of the floor a smooth mass of bone ascends pretty steeply to the point where the short process of the anvil articulates with the posterior wall of the tympanic cavity, but does not unite with the joint ; it partially

* The striæ acusticæ were distinctly marked.

changes the direction in which the fenestra rotunda opens. The mucous membrane of the tympanum is pale, but little thicker than normal, except at its periphery. *All the ossicula are entirely immobile. The fenestra rotunda is closed with bone.* An enormous quantity of otoliths was observed upon both sides, in examining the structures of the vestibulum. Even the membranous semicircular canals were occupied by them; they were of normal shape, six-sided crystals of various size, and lay in groups at the borders of the canals, while they were fewer in number at the middle. The left tympanum was in general like the right, but had not the bony growths. The access to the fenestra rotunda was free, but the fenestra was closed by bone; all the ossicles were also immovable; when very firm pressure was made upon the end of the handle, a very slight movement in the articulation between the hammer and anvil took place.

The roofs of both vestibula were very thick and compact; the capacity of the cavities very small. The contour of the plate of the stapes was still distinct upon the right side; upon the left it was distinct below, but not above. Upon the vestibular surface of the left stirrup-plate there were little knobby growths, and a very slight hyperæmia of the periosteum on the vestibular surfaces and adjacent parts of both plates; the same also on the bony part of the tympanic cavity, lying above the fenestra ovalis.

Upon examination of the other portions of the nervous apparatus it was found that there was fresh hemorrhagic infiltration in the sheaths of both the facial and auditory nerves; in the facial this could be traced to some distance beyond its first flexure, and in the auditory, distinctly as far as the modiolus. The microscopical examination of all the spires of the cochlea showed on both sides signs of recent and old hemorrhage; the recent was distinctly visible to the naked eye. The lamina spiralis membranacea had a brown-red appearance. But both these conditions were more marked upon the right side than on the left; only the membrane of Corti on the left presented an exception to this, in so far as that the signs of old hemorrhage were very prominent, while that on the right was quite free. As regards the distribution of the hemorrhages in the different regions of the lamina spiralis, the portions chiefly affected were the region where the nerves pass through in the lamina spiralis ossea, the dentate projections of Huschke and the arches of Corti; in the region of the

zona pectinata there were found no traces of fresh bleeding, and but few of an older date. Microscopically, the fresh hemorrhage * was characterized by larger or smaller groups of extravasated blood-corpuscles; the blood-vessels were very full; the old hemorrhages presented globular bodies, brown or pigmented, in some cases lying singly, in others in groups. In many cases a number of such dark globular bodies were seen surrounded by a membrane, which gave the impression of cells containing blood-corpuscles, of which I have already described an instance in a case of gunshot wound of the ear, complicated with hemorrhage in the labyrinth (in these Archives, Vol ii., part 1, p. 343, etc.).

The following further changes were noted in the several regions:

The epithelium of the crista spiralis, the large-celled epithelium of the sulcus spiralis internus, the smaller epithelium cells in the neighborhood of the inner roof of the organ of Corti, and finally the outer epithelial cells of the ductus cochlearis—all had lost their normal appearance, and were in the condition of fatty metamorphosis, just as in the previously-described case. The interdental notches were entirely filled with these altered cells, and there were but few places where the space between the anterior edges of the teeth could be clearly recognized.

The substance of the teeth was also changed. The fine homogeneous longitudinal striation had disappeared; in its place there were fine granules of fat arranged like strings of beads, corresponding to the long axis of the teeth, and in some spots the teeth were also infiltrated with fat granules, gathered in heaps. The arches of Corti had undergone the same change, and in the phalanges this had extended so far that the contours of the heads of the phalanges could scarcely be distinguished with clearness, while this was still quite easy to do with the arches themselves. The membrana basilaris had taken the least share in this alteration. It was somewhat more cloudy than usual, but in picked preparations it was easy to see that it had undergone no changes in its texture; at least, its light homogeneous longitudinal striation was distinct; and the cloudiness was chiefly caused by layers

* The fresh hemorrhage was found on the right in the second convolution, still more n the third; in the left not at all.

of epithelial cells in a state of fatty degeneration in the various regions.

The blood-vessels, both the periosteal and the spiral, showed alterations. They likewise were covered for the most part with a finely granular, fatty detritus like protoplasm ; in certain portions of picked preparations, the endothelium cells in a state of fatty degeneration were distinctly observable.*

Epicrisis.

This case presents special interest in several respects.

The changes in the sound-conducting apparatus, cloudiness of the mucous membrane, and immobility of the ossicula, correspond with those so often described in literature, which follow long insidious processes of inflammation in the middle ear ; they explain also the violent subjective sensation of hearing, experienced during the early part of the disease. The complete annihilation of the function is explained by this condition of things, and by the changes in the cochlea. The latter, again, explain the diminished violence of the subjective sensations during the latter years of life. With the fatty changes in the finer structures of the lamina spiralis membranacea the total annihilation of the function was brought to pass, and, naturally, the transference of diseased irritations to the central organ was also interfered with. This fatty change agrees entirely with that found in the cochlea, as described in the case of sarcoma of the auditory nerve. It is possible to entertain a doubt whether it was a result of the arrest of function for so many years, or a characteristic senile change, or dependent on both. In this respect, the results of future cases will have to be consulted. It is not an impossible supposition that the diminution of the acuity of hearing in very old persons often depends on such changes in the cochlea.

The presence of old and recent hemorrhage in the cochlea is

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* This change in the blood-vessels finds its analogy in the fatty degeneration of the ophthalmic artery in arcus senilis, pointed out by Julius Arnold. Compare "Die Bindehaut der Hornhaut und der Greisenbogen," by Dr. Julius Arnold. Heidelberg, 1860.

explained by the fatty degeneration of its blood-vessels. Such degeneration is probably sometimes the cause of those spontaneous hemorrhages in the cochlea, which are often assumed to occur, and, as I think, rightly assumed in many cases of sudden deafness.

THREE CASES OF TINNITUS AURIUM AND DEAFNESS, ACCOMPANIED BY VERY DISTINCT FLUSHING OF THE CUTANEOUS SURFACE ADJACENT TO THE EAR.

BY CHARLES H. BURNETT, M.D.,

Aural Surgeon to the Presbyterian Hospital in Philadelphia, and Surgeon-in-Charge of the Philadelphia Infirmary for Diseases of the Ear.

I HAVE been induced to make known the clinical facts connected with these three cases, not only because they are of interest in their otological connection,—for as ear-cases simply they came to my notice,—but because such cases of flushing of the cutaneous surface anywhere, whether from external violence or central irritation of the sympathetic nerve, are rare, and in many respects unsolved. I was asked to see, in consultation with Dr. T. Hollingsworth Andrews, of this city,

CASE I.—The patient was a young lady, living in affluence, 26 years old, of a large, handsome figure, unmarried, residing in the western part of Pennsylvania.

Six years previous to the time I saw her. she had suffered from an attack of rheumatic facial paralysis on the right side. Within two or three years she has noticed a diminution in hearing, accompanied by an uninterrupted and distressing tinnitus aurium.

The hearing is reduced on the right side to $\frac{3}{60}$, on the left to $\frac{6}{60}$ for the watch.

The tuning-fork, placed on the vertex, is heard best in the better ear. The membrana tympani on the right side is more retracted than on the left. Lustre good. Eustachian tubes pervious.

There is constantly considerable quivering of the facial and labial muscles, and there is a marked purplish-red flush over the cheeks and neck as far as the clavicle, with an increase in the tinnitus, whenever the patient is ordinarily excited or fatigued. The application of the constant electric current from a Brenner apparatus, at the time of the examination, afforded not even a temporary relief to the tinnitus.

CASE II.—Mrs. Van C., aged 56 years, farmer's wife, a small, spare woman, states that at the menopausis she experienced a sudden and excessive tinnitus aurium, which, however, has diminished in severity since then; but, although quite endurable, has never entirely ceased.

The hearing is not affected in this case. There is, however, a peculiar vascular congestion or flushing, looking like a thin carmine stain, which comes on with any considerable excitement or fatigue; is attended by an increase in the tinnitus, and extends from the ears, simultaneously over each sterno-cleido mastoid muscle, forward towards the thyroid gland, where the blushes of each side coalesce and extend over the chest and mammæ. At the same time, a similar blush extends over the nucha and upper part of the dorsum, and the patient is apparently enveloped in a carmine-colored apron, with the limits already designated. The rest of the surface is sallow. In this case the tinnitus diminished under the use of strychnia ($\frac{1}{60}$ gr. t. d.) for a month; but upon discontinuing the drug, the tinnitus returned partially.

The flushing in this case is different from that subjective flushing experienced by females at the menopausis.

CASE III.—Mrs. McA., of Delaware, a very large, strong woman, aged 45, living in a malarial district, and now pregnant with the eleventh child. The patient states that she has had an increasing hardness of hearing with tinnitus, on both sides for some years.

The membranæ tympani are opaque. In her case there is a peculiar vascular flush on the left cheek, corresponding to the ear most afflicted with the tinnitus, aggravated by exertion, heat, or cold, and coincident with an increase in the tinnitus.

This case improved under strychnia ($\frac{1}{45}$ gr.) three times daily, and the daily use of the constant electric current for a week. As she was obliged to return to her home at a distance, the electric treatment was discontinued, with a hope of its resumption after the termination of her pregnancy, if the tinnitus should demand further treatment.

Unfortunately, I have been unable to continually observe these cases, as they have all resided at great distances from me.

Their histories will, nevertheless, afford examples of tinnitus aurium and reddening of the surface brought about most probably by an irritation of the sympathetic nerve, and may add something to the knowledge of a form of aural disease to be considered one in which the nervous element truly predominates.

In a case of direct mechanical violence to the sympathetic

nerve,* the only known case at that time on record, "the face presented, after walking in the heat, a distinct flush on the right side, and was pale on the left. The right half of the face was very red. The flush extended to the middle line, but was less definite as to its limit on the chin and lips than above these points."

Dr. Wm. Ogle † has reported an instance of probable destruction of the right cervical sympathetic by abscesses. In this case "the eyeball was retracted, the palpebral fissure narrowed, the pupil contracted, the right side of the face redder and hotter than the left during repose, but after violent exercise or fever, colder. The left side of the face alone sweated, and the right side of the mouth and tongue was complained of as being dry."

In a case, under the care of M. Trélat, at the St. Louis, in Paris,‡ in which the sympathetic nerve had been destroyed by an operation for removal of a deep-seated tumor of the neck, "on the day following the operation, the face was deeply congested, especially on the right side, which displayed well-defined patches of a violet and red color."

I have cited these cases, because they present instances of flushing from a known and direct lesion of the sympathetic nerve. In the three cases I have related without any history of violence to the sympathetic, we have marked flushing with tinnitus aurium. There is no mention of this latter symptom in any of the cases I have referred to, nevertheless I think it is evident we may conclude that in cases such as I have observed, the sympathetic nerve is affected, and to it our treatment should be directed.

As published accounts of cases similar to the three I have described, are rare, I have thought that these I have given might not be devoid of interest to the readers of the Archives.

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* "Gunshot and Other Injuries of the Nerves." Mitchell, Morehouse & Keen. 1874. Philadelphia.

† Medico-Chirurgical Trans., Vol. LII., p. 154.

‡ From abstract in Med. Press and Circular, p. 78, Jan., 1869.

ON THE DIAGNOSIS OF ONE-SIDED DEAFNESS.

By H. KNAPP.

In diagnosticating one-sided deafness, we are accustomed to avail ourselves of the conduction of sound through the cranial bones. If, in one-sided deafness, a watch or, better, a tuning-fork, is placed on the incisor-teeth, or some point in the middle line of the skull, its sound is heard on the side of the healthy ear only. If, under the same conditions, this ear is closed, the sound is heard more loudly, whereas the closure of the other ear has no influence on the perception of sound. The "bone conduction," however, is frequently unreliable or unavailing. Persons of undeveloped powers of observation are unable to tell on which side of the head they hear the sound, and their preconceived ideas commonly place its enforcement by closure on the wrong side. In persons over forty-five years of age the bone conduction, tested with tuning-fork or watch, is frequently wanting, though the hearing be normal. On the other hand, when it exists, there is no means of excluding its influence upon the perception of sound. However carefully, for instance, we close our ears, we are still able to understand loud conversation. The ordinary tests of hearing—watch, voice, musical instruments, tuning-forks, etc.—when employed in the usual manner, suffice to determine hardness of hearing, but are insufficient to ascertain complete deafness of one ear, when the hearing of the other is not greatly impaired. To supplement the well-known tuning-fork test which, as above-mentioned, is not always available, I may recommend two other methods which are applicable, and, I think, yield reliable results in all cases. The one will be understood by the following remarks:

If a vibrating tuning-fork is moved up and down, before a healthy ear, its sound appears enforced as often as the instrument passes the level of the external auditory canal. If we, how-

ever, tightly close the ear before which the fork is moved, the sound appears no longer periodically louder, but uniform, being perceived mainly by the other ear. If the closure of the one ear is not complete, the periodic enforcement is still perceptible, though less marked. If a vibrating tuning-fork is moved up and down before a totally deaf ear, the sound of the tuning-fork invariably appears uniform. The waves of sound, in this case, travel in circuitous roads around the head to the membrana tympani of the healthy ear, never impinging on it in a direct way, which, in the previous experiment, produced the periodic enforcement of sound.

To illustrate the application and usefulness of this method, I may be allowed to report the following observation:

X. X., the daughter of N. R., of Philadelphia, Pa., æt. 13, consulted me on the 7th November, 1874. A year previously her parents had accidentally noticed that she was deaf in her right ear. They took her to a well-known surgeon, under whose care she had been ever since, but the treatment was without any result. She had had scarlet-fever and measles in her childhood, but her ears had never been affected as far as the parents could notice, and she has continued in good health. I found the *left* ear normal in all the parts accessible to physical examination, its acuteness of hearing greater than the average standard, namely, $h = \frac{20}{10}$, $v = \frac{30}{20}$, $m = \frac{80}{80}$, or more. The pharynx was healthy. The external meatus of the *right* ear was narrower than that of the left. It contained normal ear-wax, but, in addition, a moderate quantity of white scales in its inner third. After removing the wax and scales by soaking, syringing, and wiping with cotton-wool, I found the walls of the canal and the membrana tympani fairly healthy, with the exception of some retraction of the anterior part of the drumhead. On inflation by Politzer's method and the Eustachian catheter, the air was heard freely to enter the tympanic cavity, without producing any change in the appearance of the drumhead. The left ear being closed, the tick of a watch of 10′ hearing distance was not heard by the right ear through the air, nor on contact with the auricle. But when the watch was firmly pressed against the ear, its tick was faintly perceived. When placed on the temporal or the mastoid region, it was distinctly heard, and louder still when placed on the forehead. The right ear remaining closed, a loud voice was understood at a distance of two feet, and the strains of a small musical box was heard at a distance of six feet from the right ear, that is $v = \frac{2}{60}$, and

$m = \frac{6}{60}$. The acuteness of hearing remained the same when both ears were closed. When vibrating tuning-forks were moved up and down before the left ear, she heard a corresponding periodic enforcement of the sound like the "puffs of a locomotive," as she very appropriately described it. When tuning-forks were moved up and down before the right ear, she heard them only when the vibrations were strong, and she heard a uniform, "even," sound. Closing the left ear, she heard the loudest sound of the tuning-fork for a few seconds only and "evenly." Tuning-forks, placed on the teeth or the forehead, were heard on the left side only, their sound was louder when the left ear was closed, but remained the same when the right ear was closed or kept open.

These tests furnished very precise results, and the conclusive evidence that all the patient could hear, she did hear with the left ear. I told the parents that, in my opinion, the right ear was totally deaf, and not amenable to treatment.

In the other method of detecting one-sided deafness, the pneumatic otoscope of *Siegle* is made use of. When we apply this instrument to our own ears, the movements of the drumhead are distinctly perceived as a sound at a low pitch. Patients hearing well with one ear, but being deaf in the other, hear the difference readily—the healthy ear receiving a marked sensation of sound, the deaf ear no sensation of sound at all.

The following case illustrates this and the other tests :

On the 11th of November I was consulted by Mrs. M. B., of Montreal, Canada, a healthy-looking lady of twenty-five years of age, who gave the following history of her case : When she was four years old she had scarlet fever, which left no sequels, and did not affect her ears at all. When she was eight years old, one day, while on her way to school, and trying to cross a street crowded with wagons, she was thrown down by a horse and kicked with the hoof on her right temple. She was carried in an unconscious state to the school-house and thence to her home, where she soon recovered her senses, but suffered with nausea for some days. For some weeks she was inclined to dizziness, and, when she lay down, the objects around her seemed to move as if she were on board of an ocean vessel. These symptoms disappeared gradually, and she has been well ever since. Six years ago she discovered accidentally—on being addressed by a woman, standing at her right side—that she was hard of hearing in her right ear. Not being annoyed by it, she consulted no physician.

Status præsens: An angular scar in right temporal region. External ears and drumheads normal and alike on both sides. Pharynx healthy. Both drums readily inflatable. Hearing on left side more than normally acute. Right h, v, and $m = 0$. $h = \frac{1}{\infty}$, when watch in contact with bone: the sound louder, when watch is placed nearer to the other ear. Tuning-fork from teeth and forehead heard in left ear only, enforced when left ear is closed, whereas closure of the right has no effect. A vibrating tuning-fork, moved up and down before the left ear, produces periodic enforcements of sound, "puffs"; but is heard uniformly when moved before the other ear. *Examined with the pneumatic speculum, both drums are movable—the left with a distinct sensation of sound, the right without any.*

I have no doubt that the right ear was completely deaf, and think that the blow from the hoof of the horse on the right temple occasioned a fracture of the walls of the labyrinth. The symptoms mentioned above: unconsciousness, vertigo, apparent motions of objects when she lay down, point to an affection of the labyrinth. Cases of double-sided traumatic deafness, occurring under similar symptoms, are not very rare. Further observation and more accurate examination will, perhaps, furnish also a greater number of cases of one-sided deafness than has been hitherto noticed. If we bear in mind how frequently and heavily children will fall on their heads, we may well be astonished at the rarity of permanent injury they receive. Though their bones be more elastic than those of adults, I sometimes thought that a fracture of the petrous bone, the densest and most brittle bone in the human body, might have been the cause of deaf-mutism of children, in whom no general disease of any kind nor any abnormity in the parts of the auditory organs accessible to physical examination, could account for the absence of hearing-power. Perfect deafness is caused either by a disease in the labyrinth or the brain, and seems to be irremediable. To facilitate its diagnosis when it exists on one side only, and to assist in a correct appreciation of the cases as to prognosis and treatment, the above-mentioned methods of examination will be found useful, and, I think, sufficient. They are, briefly recapitulated, as follows:

Firstly. In one-sided complete deafness, a tuning-fork, vibrating on the incisor teeth or the middle line of the skull, is heard on one side only. Its sound is enforced when the ear of this side

is closed, but remains unchanged when the other ear is closed. This method is well known, but in many cases unavailable.

Secondly. A vibrating tuning-fork moved up and down before a healthy ear, causes an enforcement of sound, like the puffs of a locomotive, as often as it passes the level of the external auditory canal. When moved before a totally deaf ear, its sound is still perceived, *i.e.*, by the other ear, but uniformly, that is, without periodic enforcements.

Thirdly. The pneumatic otoscope in a healthy ear makes the movements of the membrana tympani audible as a deep, but distinct sound, whereas, in a totally deaf ear, it produces no sensation of sound at all.

ON FIBROMA OF THE LOBULE OF THE EAR.

By H. KNAPP.

During the last six years I have met with 7 or 8 cases of fibroma of the lobule of the ear. They all originated in the places in which the ears were pierced. They grew slowly after inflammatory irritation of this part. Chronic inflammation is frequently observed after the first introduction of a thread or metallic wire into the canal of the wound. As a rule, it disappears, and the ear is only disfigured by the foreign appendage. In other cases, the inflammatory swelling disappears, but the aim of the operation, the establishment of a canal, is not attained. Jewellers, however, come to the assistance of these unfortunate people, by selling them ingenious clasps by which these elegant ornaments can be fastened to the ear, that is, until the spring relaxes, and the jewel falls to the ground. In other cases, again—and these are comparatively numerous—the lobe of the ear is gradually divided while inflammatory symptoms are either present or absent. Tumors are so seldom met with after the ears have been pierced, that some authors, for instance, *Lawrence Turnbull*, are not inclined to take them as a consequence of the injury alone, but let a peculiar condition of the system, especially scrofulosis, or a galvanic action of the alloyed metals of the ear-ring, play a part in their production. I think that these tumors exemplify in a typical manner the fact that chronic inflammation, by organization of the exudation, lead to the formation of tumors, especially of connective-tissue tumors. Another well-known example of the same fact is the development of chalazia and larger fibrous tumors in the eyelids. In the lobe of the ear the perforation causes a slight inflammation, which in the majority of cases is followed by no unpleasant consequences; in rare cases, however, the wearing of a foreign body in the canal of the wound keeps up an irritation that leads to the organization of the exuda-

tion. This theory is the more probable since the lobule of the ear has but a very slight tendency towards the spontaneous development of tumors.

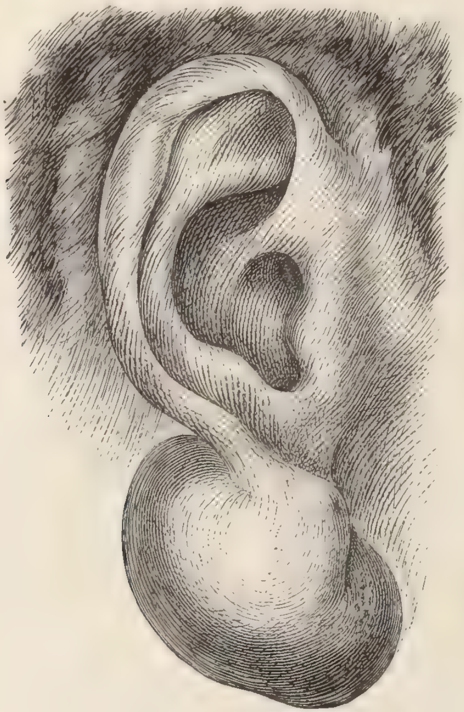

FIG. 1.

Authors state that the fibroma of the lobule occurs more frequently in the colored woman than in the white, and think the reason of it is that the poor negresses have to use earrings of commoner and heavier metal than their more fortunate white rivals.

The *diagnosis* of these tumors is easily ascertained. They present themselves as spheroidal dense swellings, the surface of which is smooth, here and there depressed, and covered with healthy skin, which is only in part movable over the tumor. The majority of them seem to project more on the posterior surface than on the anterior. The only tumor for which they may

be mistaken, is the atheroma, which, however, has a perfectly regular surface, and feels doughy or fluctuating when examined with the fingers.

The *development* of the fibroma of the lobule is slow, painless, and not accompanied by any irritation. The disfigurement and the inability to wear earrings, which these tumors cause, induce patients to seek medical help. These tumors seldom exceed the size of a filbert; in the negress, however, they sometimes grow to much larger proportions. A tumor of so extraordinary a size —that of a hen's egg—came to my notice, and induced me to write the present short communication.

The case was the following:

Mary Sh., a negress of 22 years of age, consulted me at the beginning

FIG. 2.

of November, 1874. The lobule of her right ear was the seat of a tumor, the size of a small hen's egg (see figure 1), which was ovoidal, had shallow depressions on its surface, and the skin which covered it could not be

moved without difficulty. Its consistence was that of a tough fibrous tumor. The growth was in such a way connected with the lobule that the shape of the lobule was still recognizable on its anterior surface, whereas its posterior surface was lost in the tumor. The junction of the cartilaginous part of the auricle, and the fibrous part of the lobule, was the upper limit of the growth. An indrawn cicatrix on the anterior surface of the lobule indicated the place where the ear had been pierced.

A similar growth, which had only the size of a hazelnut (see figure 2), was on the lobule of the other ear. It likewise projected more on the posterior surface than on the anterior; but a roundish swelling around the cicatrix of the perforation on the front surface showed that the growth had not sprung from the posterior part of the lobule alone, but from the whole extent of the canal.

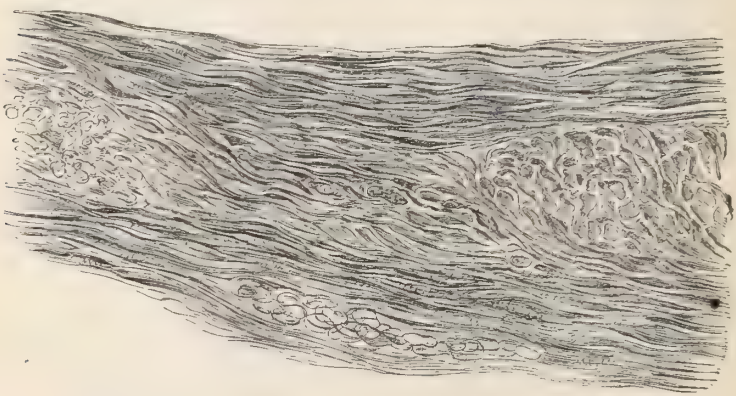

FIG. 3.

Both ears were otherwise well formed, and had never suffered from eczema or otorrhœa. Two years before the operation the patient had her ears pierced, and wore heavy, common earrings about one year. The lobes became gradually thicker, and obliged her to remove the earrings, but the tumors continued steadily increasing.

I removed the larger tumor by dissecting from it an anterior and a posterior flap, and then separating it from its connection with the auricle above, and the skin of the lobule in front. The flaps were so shaped that after their union they reëstablished the lobe of the ear in a manner quite satisfactory. I united them with ordinary sutures, and to render the scar less conspicuous I had formed the anterior flap so much larger, as was necessary to double its edge and apply the sutures at the posterior

surface of the newly-formed lobule. The lobule had the shape of the natural lobule, but its centre was somewhat thickened.

The operation on the other ear was simple. I made an incision from the lower end of the helix downward through the skin which covered the tumor, corresponding to the edge of the lobule. I then dissected the skin from both sides of the tumor, and removed the tumor by separating it from its further connections. Slight modelling of the flaps, and uniting them by ordinary sutures, was sufficient to restore a well-shaped lobule. In both cases the wounds healed by first intention.

Four months after the operation I saw the patient again, and found her left lobule slightly thickened in the centre, but her right was swollen to form a roundish, dense tumor the size of a cherry. A relapse of the growth, requiring another operation, had manifestly taken place.

The section surface of both tumors showed a dense trabecular framework with darker, more homogeneous interspaces. (See figure 3.) A canal, which was filled with débris of tissue, indicated in both tumors the places through which the earrings had passed. Fibrous trabecles radiated from this canal in different directions. They consisted of tough connective tissue, the fibrillæ of which lay close together, admitting only a few cells between them. The softer and semi-transparent interspaces between the trabecles contained a larger quantity of roundish, spindle-shaped, and stellate cells, which anastomosed with one another, and were separated by an abundant homogeneous or finely-striated intercellular substance. Mucoid and chondroid tissues were not found in the specimens. Both growths, as it is evident, were pure fibromata originated in the ground tissue of the lobule, which is fibrous in contra-distinction with the cartilaginous ground tissue of the auricle.

I have already mentioned that I consider these tumors as the result of the irritation which is kept up by the presence of a foreign body in the wound.

BILLROTH * states "that these tumors consist chiefly of fusiform cells and connective tissue, and are nothing more than hypertrophy of a cicatrix, such as occurs in other parts of the body after injuries." No objection can be raised to this view, if we

* General Surgical Pathology and Therapeutics. Translated by C. E. Hackley, p. 551.

have to deal with tumors that developed from the ends of the perforation on the outside of the lobule. They form round or oval nodes upon one or both surfaces of the lobule, leaving the lobule itself unchanged, as SIR WILLIAM WILDE * has described and illustrated. If, however, these tumors do not develop on the surface, but in the substance of the lobule, which they replace more or less completely, as in the case described above, their pathogenesis is best accounted for by a hyperplasia of the fibrous tissue of the lobule, which resulted from the irritation kept up by the foreign body, and developed into a smaller or larger fibroma.

Some authors state that fibromata of the lobule of the ear are apt to recur after their removal. The case described above is the only example, in my own experience, that confirms this statement. Relapses, if they occur in these benign tumors, are doubtless occasioned only by an incomplete extirpation of the original tumor. To secure a complete removal, the methods of operation have to be varied according to the differences of quality, seat, and size these tumors exhibit. Small tumors, and such as develop mainly on the ends of the orifices of the previous canal, but pass through the lobe, should be dissected out, and the roundish or elliptical opening closed with sutures, as WILDE did in his case. "It healed kindly, and the disease did not return." ROOSA† states: "The removal is readily effected by a V-shaped incision made with strong scissors. The edges of the wound are brought together by sutures." This method, the only one mentioned in this text-book, is not unobjectionable. In small tumors it involves a loss of tissue, and consequently a reduction in the size of the lobule, which is greater than in the method followed by Wilde; furthermore, the lobule easily loses its regular outline, and is notched, unless special precautions are taken. (See these Archives, vol. iii., No. 1, p. 254.) In large tumors both these methods would result in either incomplete removal or the sacrifice of the lobe of the ear. The restoration of the lobule requires a method similar to the one described in the above case, viz.: the formation of flaps taken from the skin covering the tumor. These flaps, however, should be so thin that no tissue of the tumor adheres to them, lest the growth return. It may not be quite easy

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* Aural Surgery, chap. iv.

† Diseases of the Ear, 1873, p. 107.

to enucleate the growth radically, since even in the natural state the skin is so densely connected with the underlying fibrous tissue of the lobule that we cannot raise it with the fingers. Yet I think it possible, with a knife, cleanly to dissect two flaps of skin from a large tumor, and to restore a well-shaped lobule in which the disease does not return. In the case described above I preserved a thin layer of the tumor lining the anterior flap. Being a mere hyperplasia of the normal fibrous tissue of the lobule, it might, I thought, serve as a support to the new lobule. The foreign body, the cause of the hyperplasia, not being present any longer, I imagined there might be no relapse of the tumor. This view was erroneous, as I might have expected. We all know that tumors, when once called into existence by any cause, are apt to continue growing after the cause has ceased to act, and when incompletely removed, the part left behind most frequently becomes the starting point of a new tumor. Failures teach caution, and to learn the causes of failure is the beginning of success. From this point of view the publication of the above case and the accompanying remarks may be judged with indulgence.

OTOLOGICAL REVIEW.

By CLARENCE J. BLAKE, of Boston.

1. N. Rüdinger. Atlas des Menschlichen Gehörorgans, Dritte Lieferung. E. Stahl, München, 1875.

2. Rüdinger. Atlas of the Osseous Anatomy of the Human Ear. Translated and edited by Clarence J.. Blake, M.D. A. Williams & Co., Boston, 1874.

3. Sedley Taylor. Science of Music. D. Appleton & Co., New York.

4. F. Coyteux. Études sur la Physiologie. Chap. XI., De L'ouïe. G. Masson, Paris, 1875.

5. Adolph Fick. Compendium der Physiologie des Menschen, Kap. 4, Gehörsinn. Wilhelm Braumüller. Wien, 1874.

6. De la Charrière, Isambert, et Krishaber. Annales des Maladies de l'Oreille et du Larynx. G. Masson, Paris, 1875.

7. J. Patterson Cassells. Fungous Ear Diseases. Medico-Chirurgical Soc., Glasgow, 1874.

8. C. H. Burnett. An Objective Noise in the Ear accompanied by Spasmodic Retraction of the Membrana Tympani and of the Velum Palati. *Philadelphia Medical Times*, February, 1875.

1. The third and final volume of Prof. Rüdinger's Atlas concludes a labor extending over a period of more than ten years, which has contributed to otological literature one of its best works for reference and for illustration. The application of photography to the illustration of papers and treatises upon the anatomy of the ear has, as the author says in his preface, the advantage of affording a faithful reproduction of the delicate structures of the ear, which may serve not only for purposes of study and instruction, but may also assist the student in the reproduction of the anatomical preparations. The first volume contained eight photographic and two lithographic plates ; the second volume, eight photographic and four lithographic plates ; and the third volume, thirty-eight photographic

plates, comprising in all one hundred and nine figures. The photographs for the first and second volumes are from the celebrated atelier of Albert, in Munich, and are remarkable for their softness of outline and delicacy of finish. The illustrations of the third volume are by Gemoser and Waltl; the softness of outline which rendered the pictures of Albert particularly pleasing is wanting in these illustrations, but this is in a measure largely due to the character of the subjects which rendered some retouching of the negatives necessary, and to the methods of reproduction. The first four plates of the third volume comprise sections of the temporal bone. Of these the nine figures in Plates III. and IV., are particularly valuable as showing the relations of the mastoid cells and middle and internal ears.

Figs. 2 and 5, Plate III., give vertical sections of the middle ear, which display the important points of the walls of that cavity.

Figs. 1, 2, 3 and 4, Plate IV., present horizontal sections of the temporal bone, displaying

1. The external auditory canal, tympanic cavity, the stapes in position, mastoid cells, internal auditory canal, the cochlea, and vestibule.

3. The external auditory canal and tympanum, with the ossicula in position, the Eustachian tube, vestibule and aqueductus vestibuli and cochleæ.

These figures would prove especially valuable in an enlarged form in explaining the relations of the external, middle and internal ear to a class.

Plate V., 1. Right membrana tympani with the membrana propria and malleus viewed from within.

2. Section horizontally through the articulation of incus and stapes, with the attachment of the tendon of the musculus stapedius.

3. Section horizontally of the fenestra ovalis, in connection with the posterior segment of the stapes.

Plate VI. Sections horizontally of the malleus, showing its relations to the membrana tympani, and of the articulation of the malleus and incus.

Plate VII. Corrosion preparations of the labyrinth, magnified four and one-half diameters.

Plate VIII. The osseous and membranous labyrinth, showing the osseous labyrinth free from the investing bone, the semi-circular canals, vestibule and commencement of the first whorl of the cochlea being opened in order to exhibit the membranous parts in position.

Three sections of the cochlea in different planes, magnified twelve diameters.

Plate IX. Schema of the labyrinth of the mammalia, after Waldeyer, and the membranous labyrinth of the vestibule and semicircular canals with the nerves, magnified nine diameters.

Plate X. Two sections of the cartilaginous and membranous canals from a three and four months' fœtus respectively, magnified eighty-four diameters, and a section of the same parts in the adult, under the same magnifying power, and also a cross section of the membranous semi-circular canal, showing the papillæ.

Plate XI. Section through the first whorl of the cochlea of a kitten, after Boettcher, and a section from apex to base of the cochlea of the human fœtus at about the fourth month.

Plate XII. Upper portion of section through the posterior root of the nervus acusticus, after Henle.

Sacculus rotundus of the fœtus, with the nervus saccularis major.

Cross section of the ampulla membranacea of the pike.

Vertical section of the organ of Corti, with the nerves, from a dog, after Henle, and the facial and auditory nerves with the ganglia.

Plate XIII. Comprises four figures, showing the base of the brain and origin of the auditory nerve, the inner surface of the base of the cranium, the nervus trigeminus and otic ganglion viewed from within, and the nerves of the tympanic cavity viewed from without. This plate is followed by a wood-cut, giving a schematic representation of the tympanic plexus which will prove of great service to the student.

Plate XIV. Has also four figures representing the tympanic cavity with the nervus facialis and chorda tympani.

The nervus auriculo-temporalis and its distribution in the external ear. The nerves of the outer ear, and finally the ramus auricularis nervi vagi. The work concludes with an index of the plates and figures comprised in the three volumes.

While anything more than an enumeration of the contents of such an atlas would hardly come within the scope of such a review as the present, it is impossible to dismiss this admirable work without a thought of the labor which its production implies and the judgment shown by its author in the arrangement of its several parts. The form of the work also makes it easily available for reference, and, the plates being unbound, may be mounted for use in lectures or for class instruction.

2. The Atlas of the Osseous Anatomy of the Human Ear is a reproduction of the eight photographic plates of the first volume of Rüdinger's Atlas, with English text, the plates having been made by Albert for the purpose. There is in addition a frontispiece plate from a preparation made by the editor, with descriptive text, and as the Atlas was intended

for class uses, a note has been added, giving the distribution of nerves and blood-vessels.

3. Among the more gratifying evidences of the growth of general scientific culture is the demand for works of a so-called popular scientific character. The works of this kind embrace a wide range, from the studies in biology for young beginners, for instance, to the more elaborate treatises embodied in our scientific reviews, published to meet the wants of advanced students. The work of Mr. Sedley Taylor stands midway between the two extremes, consisting of a series of lectures delivered at the South Kensington Museum and Academy of Music, and aiming at placing before persons unacquainted with mathematics an intelligible and succinct account of that part of the theory of sound, which constitutes the physical basis of the art of music. No preliminary knowledge, save of arithmetic and of the musical notation in common use, is assumed to be possessed by the reader.

The first, second, and third chapters treat of sound in general and the mode of its transmission, on loudness and pitch, and on resonance. The fourth chapter on quality, the low-connecting, constituent tones, experimental analysis of musical sounds, by means of the piano-forte, and Helmholtz's theory of musical quality, concludes the first part of the book. Chapter fifth treats on the essential mechanism of the principal musical instruments, considered in reference to quality, and concludes with the synthetic confirmation of Helmholtz's general theory of quality by means of the tests with combined tuning-fork tones.

Chapters sixth, seventh, and eighth treat of the connection between quality and mode of vibration, the interference of sound, and on concord and discord, and chapter ninth entitled consonant triads, treats concisely of the rules for the employment of vibration fractions, major and minor groups, and the relation between their members, the notation of thorough bass, and the effects of major and minor chords.

In concluding the final chapter on pure intonation and temperament, the author speaks of the relation of the theory of consonance and dissonance to the æsthetics of music and of the fact that the order of merit of the ear in consonance is not the same as the mechanical order ; the concords classed in order, according to their greater or less freedom from dissonance are, first, the octave, then the fifth, fourth, major third and sixth, and minor third and sixth, this being the purely physical classification. The ear, however, places thirds and sixths first, then the fourth and fifth, and the octave last of all.

The author is inclined to attribute the predilection of the ear for thirds and sixths over other concords to circumstances connected with its per-

ception of key relations, though unable to give a satisfactory account of them.

The author further considers that the ear possesses a marked distinction from other organs of sense in that it enjoys in alternation with consonant chords, dissonances of so harsh a description as to be barely endurable when sustained by themselves.

4. The eleventh chapter—comprising twenty pages—of the very comprehensive work of M. Coyteux, is devoted to the physiology of the ear, giving firstly, short explanations of the terms; intensity, tone, harmony, and timbre.

The external, middle, and internal ear are then considered in order.

Concerning the auricle, the author is disposed to favor the view of Buchanon, that the acuteness of hearing is more or less in proportion to the extent of the angle at which the auricle is set upon the head, and agrees with the conclusion drawn from Savart's experiment that the function of the auricle is not to reflect vibrations into the external auditory canal, but to convey to that passage the vibrations which are excited in its own substance, and in this connection no reference is made to the more recent experiments of Berthold, Urbantschitsch, and other German and English observers. Following a review of the opinions of Béclard, Longet, Bourget, Bernard, and others, upon the office of the membrana tympani, and the manner of transmission of sonorous vibrations, M. Coyteux concludes that the sound perceived is conveyed not only by the membrana tympani, but through the cranial bones to the membrana tympani, and the air contained in the tympanic cavity; that in this manner, together with the varying tension of the membrana tympani, the sympathetic vibration to various tones is provided for, and that the contraction of the musculus tensor tympani serves not only to maintain the membrana tympani at a proper degree of tension, but also by changing the tension of the membrana tympani to vary the tension of the air contained within the tympanic cavity, according to the sounds communicated to the contained air through the cranial bones.

The ossicula serve to receive, to condense, so to speak, all the vibrations received through the membrana tympani, or the tympanic cavity, and to transmit them to the labyrinthine fluid by means of the fenestra ovalis; in relation to the further office of the ossicula, the author gives the explanations of Savart and Longet with regard to protection of the deeper-seated and more delicate structures. In addition to the office of the Eustachian tube in maintaining the equilibrium of atmospheric pressure on both sides of the membrana tympani, which is briefly mentioned, the author gives the opinions, in which he concurs, of MM. Bressa and

Longet, that this canal serves for the transmission of the voice, existing as it does in all animals having voice, and being absent in many which make no sound. Following a description of the anatomy of the internal ear in brief, is the consideration of the physiology of this organ. It being generally admitted that the sonorous vibrations are communicated through the fenestra ovalis and fenestra rotunda, the author considers that the former serves to convey the vibrations passing through the chain of bones, and the latter the vibrations of the air contained within the tympanic cavity. That the former mode of transmission is the more important of the two is deduced from the fact, shown by comparative anatomy, that where only one of the fenestræ persists it is the fenestra ovalis with a more or less complete chain of bones.

The opinions of Müller, that the membranes of the two fenestræ transmit sounds varying not only in intensity, but also in timbre, and of Auzoux, that the membrane of the fenestra rotunda plays a special rôle in counterbalancing the pressure upon the labyrinthine fluid made by the base of the stapes, are quoted favorably, and the theory of Helmholtz in regard to the offices of the rods of Corti, the hairs of Schultze, and the otoliths is considered as a whole inadmissible.

5. Professor Fick devotes fourteen pages of his "Compendium of Physiology" to the organ of hearing, giving a résumé of the later investigations in the anatomy of the ear, followed by a description of the functions of its several parts, which represents the general standard of German observers of to-day very faithfully. "The distance of the origin of a sound," says Prof. Fick, "we determine by the intensity of the perception." The determination of the direction of the sound is largely due to the greater intensity of the perception in one ear or the other, and the position of the auricle seems to have an influence in determining the direction also, especially as to whether the point of origin of the sound is before or behind the observer. If the auricle is pressed upon with the thumb, and an artificial auricle formed by the remaining fingers, it is very difficult to determine whether the sound comes from before or behind. In regard to the office of the semi-circular canals, the author inclines to the opinion that they assist in maintenance of equilibrium, founded upon the experiments upon disturbances of motion, made by Flourens, Löwenberg, Boettcher, and other writers.

6. It is always a pleasure to welcome a new publication in the interest of special science, likely to prove the medium through which fresh contributions are to be made to the growing knowledge of the subjects of which it treats. The first number of the Annales des Maladies de l'Oreille et du Larynx commends itself, therefore, at once to consideration.

It is intended, as its authors say in their preface, to fill an existing gap in the publications consecrated to special subjects; without the pretence that the journal responds to a want generally felt, it is hoped that it may serve such readers as are desirous of exploring new fields. In regard to the otological portion of the journal, we may be permitted to quote from the preface as setting forth opinions of its authors—while the profession generally has adopted means which permit the minute investigation of morbid phenomena, the use of the otoscope, and the examination of the ear, under proper illumination, still remains in the hands of the specialist. How many physicians are there who, in the course of a grave disease, an eruptive or typhoid fever, take the pains to examine the ear with proper care? In the course of the more severe fevers, and particularly in those in which the complication of angina is common, deafness is a frequent symptom; it attracts, however, comparatively little attention, and cerebral complications are considered as the cause of symptoms which are nothing more than the result of an inflammation of the ear. If a discharge of the ear occurs, followed by a degree of amelioration of the symptoms, this is considered as a favorable crisis, without exciting investigation into the degree of the accompanying angina, and without suggesting to the practitioner that a lasting infirmity may be the consequence. Another example may be quoted in the otitis of new-born children, an affection quite as frequent as ophthalmia; while the latter malady is the object of care and of apprehension, the former, on the contrary, is treated too lightly; the nurse is allowed to inject milk into the ears, and the disease does not become a subject of concern until some months later, when the sad prospect of deaf-mutism suggests itself. An examination of the ears of children, who are the subjects of this deplorable infirmity, shows that in seventy-nine out of a hundred the hearing was lost after birth. In a certain number of these cases this might have been prevented.

The advance which has been made of late years in the study of diseases of the ear, and the communications on this subject appearing in the general medical journals of France, induce the editors to provide a means for the publication of such papers in a special journal, and the intimate relationship between diseases of the ear, the nasal passages, the pharynx, and the larynx, have determined them in uniting in the same publication those affections which are studied by means of the otoscope, the rhinoscope, and the laryngoscope.—The spirit which incites MM. Isambert, Krishaber, and Ladreit de la Charrière, in presenting their new journal to the general medical public, thereby filling a gap in French periodical medical literature, and which is indicated in their preface, should be emu-

lated by editors of other special journalistic publications. It is the part of the specialist, not only to keep himself informed in the advances made in his particular branch of science, and to contribute to them himself so far as possible, but also to spread his information among his brethren in general practice, contributing thereby as much as possible to the general advance of his profession.

The otological portion of the first number of the "Annales" is represented by a paper by Ladreit de la Charrière on Ménière's disease, which, while presenting nothing new with regard to this affection, gives the analysis of a series of cases, in which the symptom of vertigo was the result of other lesions than those of the internal ear primarily, and a paper by D. M. Levi, entitled "Observation d'Otite parasitaire," making, we believe, the first contribution to the rapidly growing list of cases of this affection, from a French source. The patient, a soldier, came under treatment in August, 1873, for relief from purulent inflammation of the left ear, having also had an acute inflammation of the right ear previously. Under treatment the discharge was entirely, and the deafness partially, relieved.

In February, 1874, the patient returned, complaining of pain and subjective noises in both ears. An examination of the right ear revealed a whitish mass, lining the external auditory canal, and covering all but the anterior superior portion of the membrana tympani. This false membrane being removed and preserved in glycerine, and then examined under a power of three hundred diameters, revealed well-marked mycelium and sporules of aspergillus nigricans. The treatment consisted in warm syringing, the instillation of a solution of nitrate of silver, one gramme to ten of water, and, later, phenic acid one gramme to three hundred of water. At the end of three weeks the canal and membrana tympani had resumed their normal appearance. In connection with the ætiology of this disease, it is worthy of note, that the patient had but lately recovered from a disease which implied continued maceration of the parts, later the seat of the parasitic growth ; that he was in the habit of sleeping, when off duty, in the garrison-stable upon mouldy hay, and that he had never used any instillation of oil, simple or medicated, which might possibly have favored the development of the fungus, as has been suggested by Bezold.

7. Dr. J. Patterson Cassels also has contributed the first case of parasitic disease of the ear recorded in Great Britain in the British Medical Journal of May, 1874, and now presents a second case in a paper read before the Medico-Chirurgical Society of Glasgow. The patient was a young lady who had suffered, as in the case of M. Levi above quoted,

from purulent inflammation of the ear, from which she had been relieved. In August, 1872, she had sensations of fulness and burning heat in the right ear, accompanied by occasional lancinating pain; in a short time the left ear became the seat of similar sensations which continued for more than a year, relieved only by occasional syringing with warm water, which brought away large, flaky-white masses. When first examined by Dr. Cassels, the hearing for the watch was reduced in the right ear to $\frac{4}{72}$, and in the left ear to $\frac{1}{72}$; the right meatus was free from cerumen, and presented a dry, scaly, white appearance. The membrana tympani presented a peculiar appearance, which was found, on closer examination, to be due to the presence of a finely-developed undergrowth of mycelium, springing out of which were numerous fructiferous hyphens or filaments, bearing black sporangia, of a spherical form. Portions of this fungus were detached and removed, and proved, under the microscope, to be perfect examples of aspergillus nigricans.

Examination of the left ear showed it to be affected with apparently the same disease, but the appearances were totally different. The meatus was filled with large masses of dead epithelium interspersed with delicate points of a dark or almost black color. A specimen of this débris was examined under the microscope, and proved to be made up of exuviated epithelial cells and other débris; the black points being the spore heads of the same fungus. In a few days, under treatment, the parasite and its effects were gone.

The treatment pursued by Dr. Cassels in this case was that previously advocated and largely employed by him in other forms of ear-diseases, namely, the application of alcohol. Syringing with tepid water alone, the author says, without the subsequent use of a parasiticide, may suffice to effect a cure; "but for my own part, especially after studying the experiments of Küchenmeister and the evidence which the history of this case affords, I would not trust to it alone, nor would I rely upon a watery solution of any of the numerous parasiticides, with the exception, perhaps, of the hypochlorate of lime. I quite concur in the opinion expressed by Hallier, and confirmed by Küchenmeister, that, of all parasiticides, those into the composition of which alcohol enters are the most effective; further, that the efficiency is in reality due to the spirit alone. Hitherto I have used alcohol either diluted or in full strength, and have good grounds to be satisfied with its action.

The principle which may be laid down as a guide to those who desire to use this substance is this: do not irritate the already inflamed tissues; in other words, let the strength of the alcoholic solution fall far short of causing pain to the patient."

8. Among the more interesting cases lately reported in American journals, mention may be made of the occurrence of an objective noise in the ear observed by Dr. Burnett.

The patient was a Japanese lad eighteen years old, who applied for treatment of a chronic suppurative inflammation of the left middle ear. While making the necessary examination, a peculiar snapping noise was heard emanating from the right ear, so distinct as to be heard at a distance of ten feet. This sound was also distinctly heard from the nostril of the right side, but not at all from the left ear. The snapping sounds began during the summer of 1874, after the attack of acute inflammation in the left ear.

At first no sign of movement of the membrana tympani could be observed with the occurrence of the snapping sound, but a manometer, placed in the right ear, showed a negative fluctuation of 0.5 mm. at each snapping sound, thus demonstrating a retraction of the membrana tympani.

Examination of the fauces revealed an elevation and retraction of the velum palati with each snapping sound in the ear and each manometric depression.

Deglutition, respiration, and speech exercised a marked influence over the spasmodic condition; on holding the breath, the contractions in the velum palati and the snapping noise in the ear ceased entirely, but recurred so soon as the patient resumed breathing. During ordinary respiration the spasms amounted to twenty in the minute, or, increasing the rapidity of breathing, they rose to thirty in the minute. During ordinary speech no spasms occurred. They were not in regular succession nor synchronous with the respiration, but occurred in groups of twos and threes with a pause between. They so far interfered with the hearing of the patient, as to induce him to hold his breath when he wished to hear distinctly; and a watch which was heard only on contact while the snapping noise occurred, was heard at a distance of two inches, when arrested by holding the breath. Tuning-forks, held before the ear, appeared to the patient to rise in pitch at each spasm.

The snapping sounds, but not the spasmodic elevations in the velum, could be arrested in two ways, by throwing the head backward as far as possible, and by pressing the finger firmly against the velum, and pushing it upward toward the pharyngeal opening of the right Eustachian tube; the powerful twitching with the usual intervals of repose could be plainly felt by the finger, but the snapping noise ceased.

Pressure upon the left half of the velum palati, and immediately upon the pharyngeal opening of the left Eustachian tube, revealed no twitch-

ing in that region, nor did it influence in any way the spasms and noises on the opposite side of the pharynx and in the right ear.

Dr. Burnett's case is a further and very clear substantiation of the view, which he quotes, of Politzer and Luschka, that in many cases such noises as those described are due to a spasmodic contraction of the muscles of the velum palati, producing a sudden separation of the anterior from the posterior wall of the pharyngeal portion of the Eustachian tube.

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